UNIVERSITY OF PENNSYLVANIA

THE WHARTON SCHOOL

MONETARY ECONOMICS 101

Professor Corbae — Fall 1996

Table of Contents

1.A

1) CLASS LECTURES

Financial Markets and Economic Activity©

Dean Corbae

The objective of this course is to understand the *inter*-relation between financial markets and markets in *real* goods and services

- Example 1: How consumer beliefs about the future state of the economy affect their spending/borrowing behavior, which spills over to the bond market.
- Example 2: How Fed policy affects short term money markets, which spills over to bond, stock, and foreign exchange markets.

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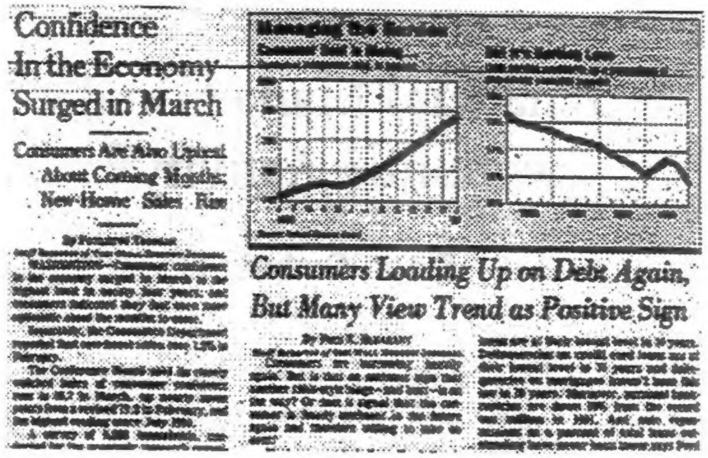
Consumer confidence and borrowing
p. A2, WSJ 3-30-94


Confidence In the Economy Surged in March

Consumers Are Also Upbeat About Coming Months; New-Home Sales Rise

Consumers Loading Up on Debt Again, But Many View Trend as Positive Sign

26

"Consumers are borrowing heavily again signaling optimism about the future"
p.C1, WSJ 3-30-94


THE WALL STREET JOURNAL

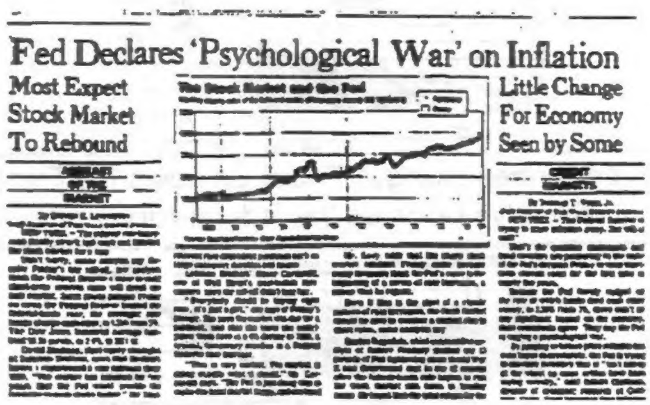
MONEY & INVESTING

Bonds Fall, Triggering Big Sell-Off in Stocks

Consumer Confidence

Wall Street Journal, 2-7-94

Fed moves to reduce inflation fears



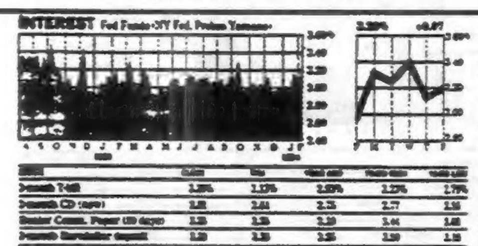
Fed Declares 'Psychological War' on Inflation

Most Expect Stock Market To Rebound

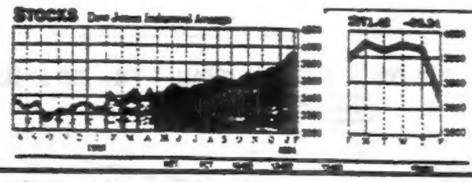
Little Change For Economy Seen by Some

In the bond market,

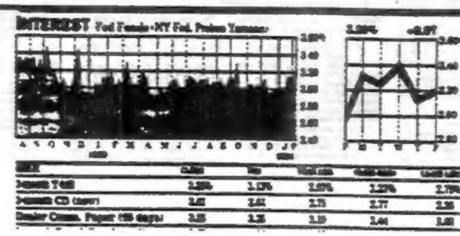
"A case can be made that the Fed's preemptive strike will be good for bond prices. But on Friday investors recoiled."



In the stock market,

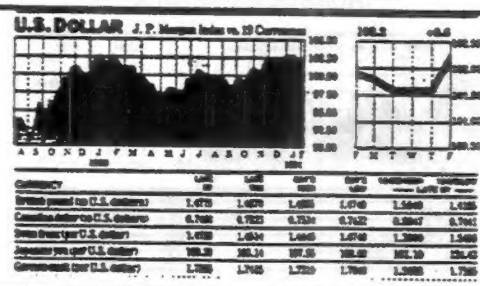


"Stock prices plunged Friday on news the Federal Reserve boosted the federal-funds rate"



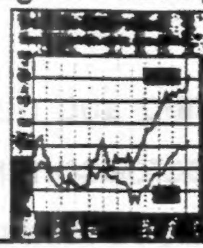
In the foreign exchange market,

As interest rates rise, the dollar's value rises against other currencies



In the derivatives market,

Derivatives Markets in the U.S. Gyrate Wildly In Heavy Trading After Fed Tightens Rates

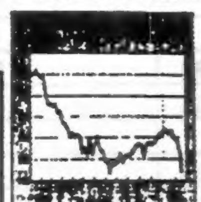


"The value of a single futures contract on the S&P 500 had plummeted $6,450."

Wall Street Journal 2-15-94

Dollar Falls 4% Against Yen in Trade Dispute

FOREIGN EXCHANGE



"Traders speculate that the Clinton administration will try using a stronger yen to prod Japan to open its markets to US goods"

"The US doesn't have to talk the dollar down; the currency market implicitly believes this is what Washington wants."

Definitions and Data

Measuring and describing macroeconomic quantities and prices

How should we measure a nation's output ?

Quantities	Corn	Washers	Total Quantity
1993	50	5	55
1994	45	8	53
Prices			
1993	$4	$10	
1994	$4	$10	

Should our measure of output be higher in 1993 than 1994 due to an absolutely larger quantity of corn ?

- We need some way to "value" output (since refrigerators are more valuable than corn).
- Use prices.
- '93 Nominal GDP is $4*50 + $10*5 = $250
- '94 Nominal GDP is $4*45 + $10*8 = $260

A Measure for Output

- Nominal Gross Domestic Product is the dollar value of all final goods and services produced in a given year originating in a particular country

i.e. $\text{Nominal GDP}_t = \sum_{i=1}^{N} P_{i,t} Y_{i,t}$

Suppose prices change but quantities don't.
Is Nominal GDP still a good output measure ?

Quantities	Corn	Washers	Total Quantity
1993	50	5	55
1994	50	5	55
Prices			
1993	$3	$8	
1994	$4	$10	

•'93 Nominal GDP is $3*50 + $8*5 = $190
•'94 Nominal GDP is $4*50 + $10*5 = $250

•We don't eat prices.

What if we value output relative
to a benchmark year ?

- Suppose we use 1993 prices to value output in 1993 and 1994:

'93 output measure is $3*50 + $8*5 = $190
'94 output measure is $3*50 + $8*5 = $190

Another Measure of Output

- Real Gross Domestic Product is the value of all final goods and services produced in a given year relative to the prices in a base year (the current base year is 1982) originating in a particular country

$$\text{i.e. } RealGDP_t = \sum_{i=1}^{N} P_i^{82} Y_{i,t}$$

What's the difference between GDP and GNP ?

- GDP is total output produced domestically independent of nation of ownership.
- GNP is total output produced by domestic residents (working at home or abroad).

Examples of GDP vs GNP

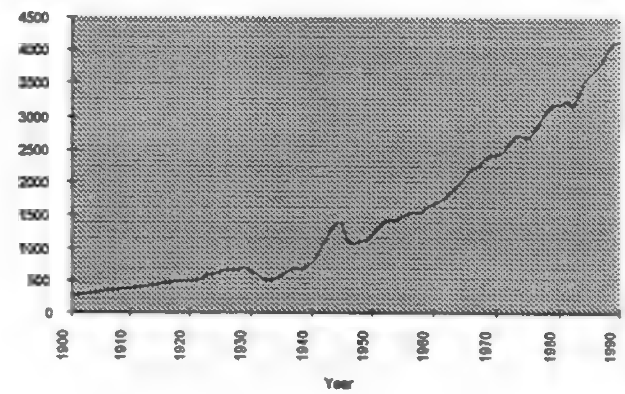
- Hondas built in Ohio are counted in US GDP but not US GNP.
- Fords built in England are counted in US GNP but not US GDP.
- Toyotas built in the Kentucky plant, which is employee owned, are counted in US GNP (and also US GDP).

The Business Cycle

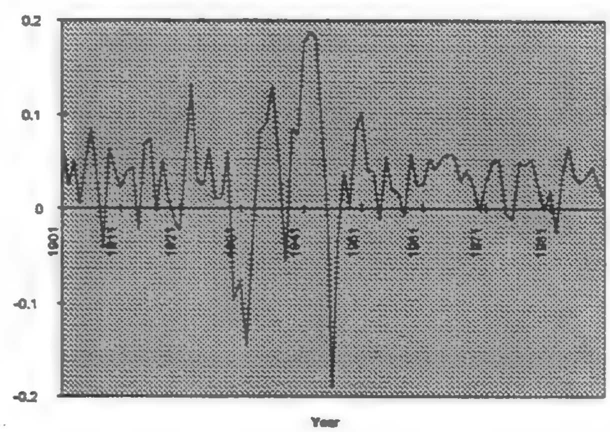
- The business cycle is the fluctuation (ebbs and flows) in real GDP.

- Officially a recession is two consecutive quarters of negative real GDP growth. An expansion is simply the period between recessions. This definition of the "business cycle" makes clear it is an irregular cycle.

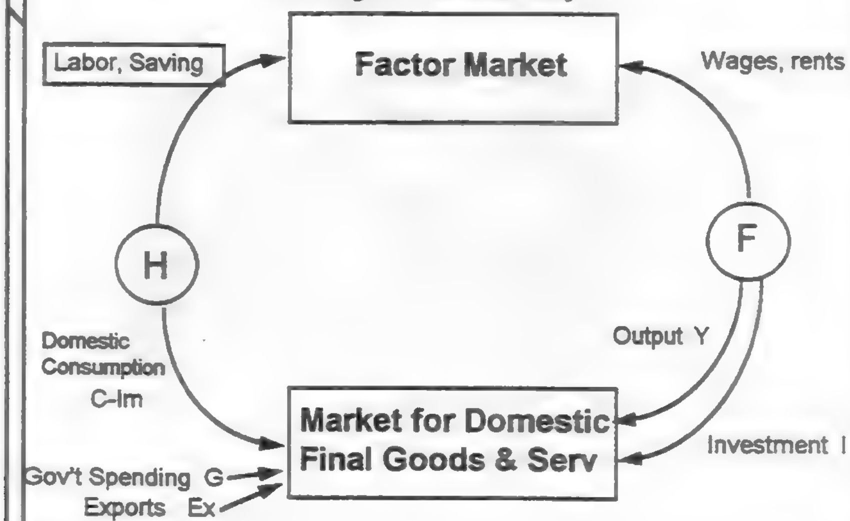
Real GDP for 1900-1990



Growth Rate of Real GDP



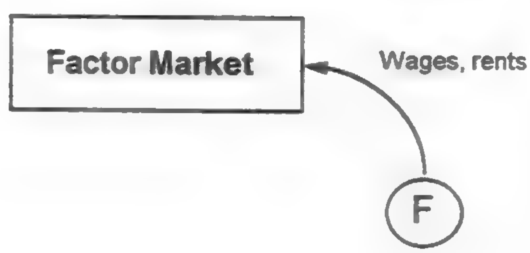
How do goods and services flow through the economy ?



- This circular flow provides us with alternative ways to measure real output via:
  - Production
  - Income
  - Expenditure

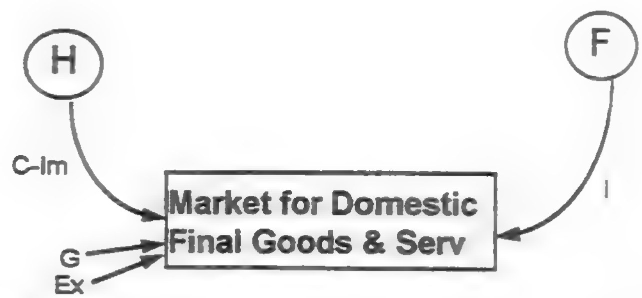
Measuring GDP via production

Measuring GDP via income



Measuring GDP via expediture

C+I+G+Ex-Im = Y



Implications of the expenditure approach

(1) Y = C+I+G+Ex-Im

(output=expenditure)

(2) Y = C+S+T

(divide income between consumption, saving and taxes)

Rearranging (1) and (2) gives

(3) Ex-Im = S-I + T-G

(trade balance=excess private saving +excess public saving)

What does this imply ?

trade balance= excess private saving - governement budget deficit

Year	United States (percentage of GDP)				Japan (percentage of GDP)			
	Ex-Im	S	I	G-T	Ex-Im	S	I	G-T
1981	0.3	18.0	16.9	1.0	0.4	35.5	31.3	3.8
1982	0.0	17.6	14.1	3.5	0.6	34.3	30.1	3.6
1983	-1.0	17.4	14.7	3.8	1.8	33.8	28.3	3.7
1984	-2.4	17.9	17.6	2.8	2.8	33.2	28.3	2.1
1985	-2.8	16.6	16.0	3.3	3.7	32.9	28.4	0.8
1986	-3.4	16.1	15.7	3.4	4.3	33.2	28.0	0.9
1987	-3.5	14.7	15.7	2.3	3.6	32.0	29.0	-0.6
1988	-2.8	15.0	15.8	1.8	2.8	32.4	30.7	-1.1

How do we come up with a simple measure of the general price level ?

Choose a basket of goods and price it in alternative years.

Basket	All Goods	10 Units Cor	One Washer
1992	$190	$30	$8
1993	$250	$40	$10

For all goods, inflation is (250-190)/190 = 0.32

For corn, inflation is (40-30)/30 = 0.33

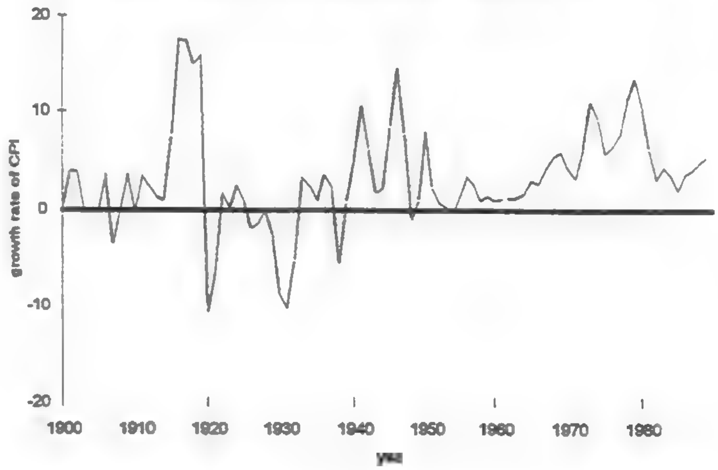
For washers, inflation is (10-8)/8 = 0.25

It should be apparent that the price level and inflation depends on the chosen market basket.

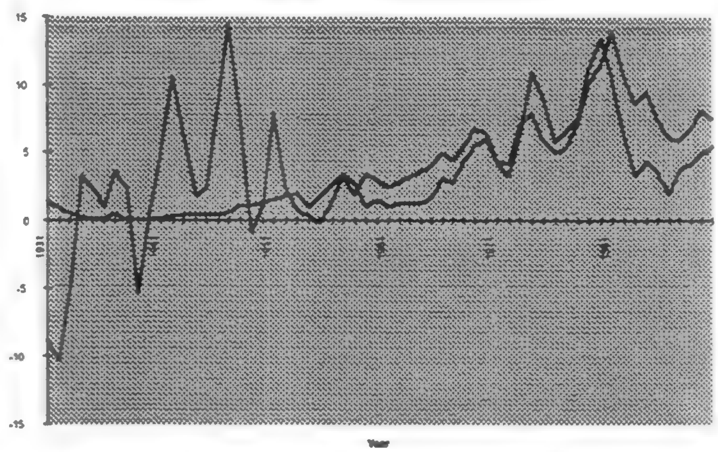
- Economists consider various bundles:
  - GNP deflator (all goods)
  - Consumer Price Index (typical consumer goods)
  - Producer Price Index (typical firm inputs)

Consumer Price Index (1985=100)

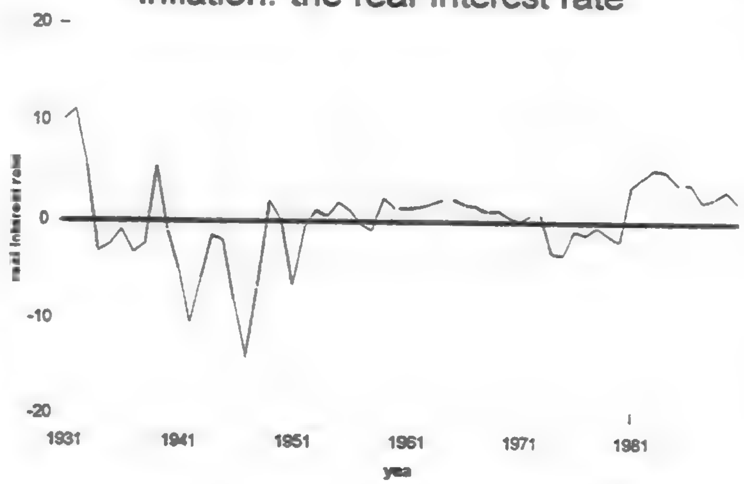
Inflation rate (growth rate of CPI)



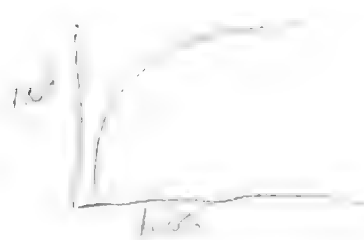
What's the relation between inflation and nominal interest rates?



Difference between 3 month treasury bills and inflation: the real interest rate



What's the relation between short and long term interest rates ? The yield curve.



How do we compare the price of two currencies ?

- The nominal exchange rate, e_t, is the number of foreign currency units that trade for one domestic currency unit

$$e_t = \frac{\#\text{ foreign currency units}}{\$\,1}$$

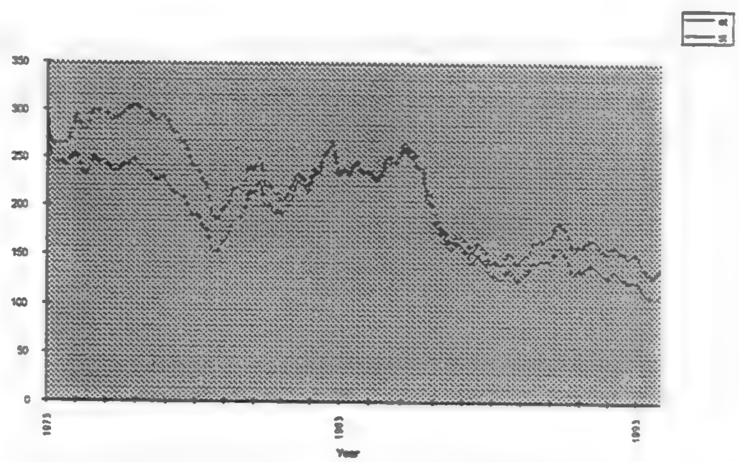
How do we compare the price of "equivalent" goods in two countries ?

- The real exchange rate, s_t, is the number of foreign goods that trade for a domestic good

$$s_t \equiv \frac{e_t P_t}{P_t^f} \equiv \frac{\dfrac{\#\text{ foreign currency units}}{1\$}\;\dfrac{\#\$}{1\text{ U.S. good}}}{\dfrac{\#\text{foreign currency units}}{1\text{ foreign good}}} \equiv \frac{\#\text{ foreign goods}}{1\text{ U.S. good}}$$

- s_t is often considered a measure of a nation's competitiveness. If s_t is high, then U.S. goods are "really" expensive.

Nominal and real exchange rate for US and Japan



Question 1

- Suppose the government does away with capital gains taxes.
- What are the implications for the trade balance?
- Hint: What do the Income Identities say?

1B

1

A Simple Model of the Determination of Ouput

2

The Model

- We consider the simplest possible "representative" economy:

  a self-employed individual who chooses between two "goods"
  - a consumption bundle
  - leisure

  in a given time period.

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This simple model is intended to highlight some important determinants of output

- Technology and production possibilities (supply)
- Preferences or tastes (demand)

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Part 1: Our model of supply

- Production possibilities are defined by

$$y_t = \theta_t f(n_t; \text{other factors})$$

where f() is the production function for labor and θ_t is the state of technology in a given time period

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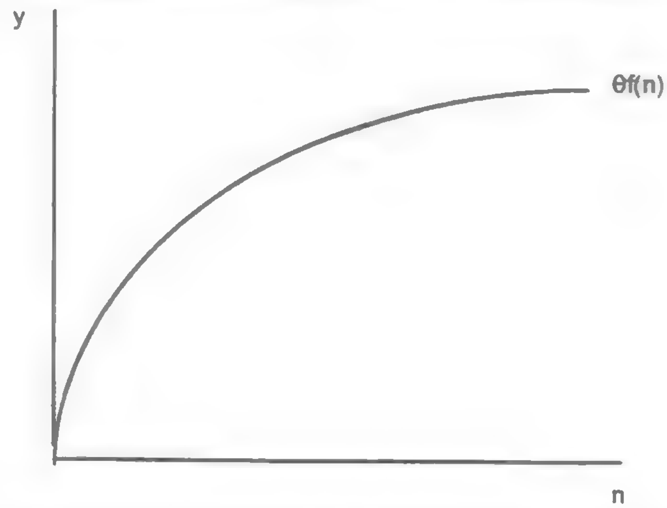
Graph of output (y) vs labor hours (n)



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As you work more what happens to "productivity" ?

- As pictured, the production function exhibits diminishing marginal returns.
- That is, as labor hours rise, each hour becomes less productive (generates less output).
- E.g. You can only fit so many workers on a machine.

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Productivity Measures

- The Wall Street Journal typically defines "productivity" as the average product of labor (APL) which is just output per labor hour (y/n).

- APL can be viewed as the slope of a line from the origin to a point on the production function associated with a given labor input level.

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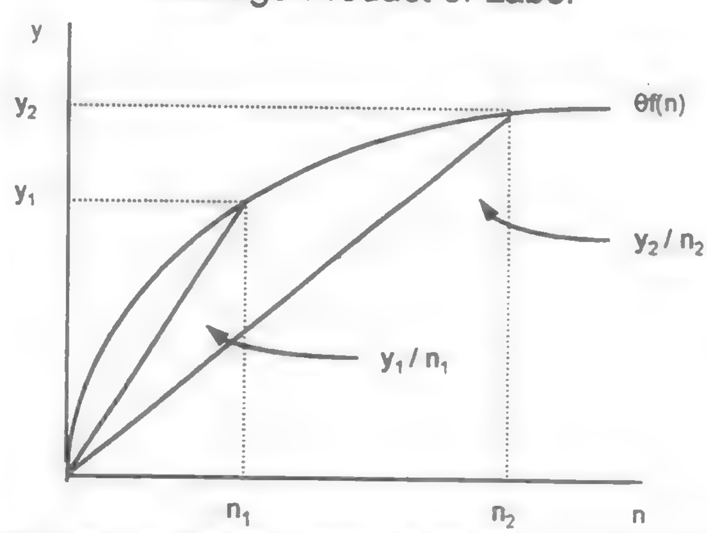
Average Product of Labor



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Another productivity measure

- The marginal product of labor (MPL) is defined to be the incremental change in output for an incremental change in labor input.
- MPL can be viewed as the slope of the production function at a given labor input level.

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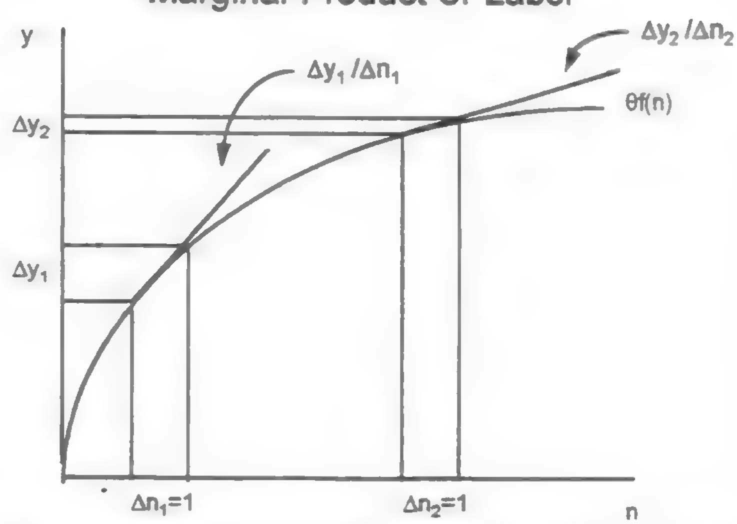
Marginal Product of Labor



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As labor hours increase what happens to MPL ?

- MPL decreases as labor hours increase due to the Law of Diminishing Returns
- We can see this graphically since the slope of the production function decreases for higher levels of labor input.

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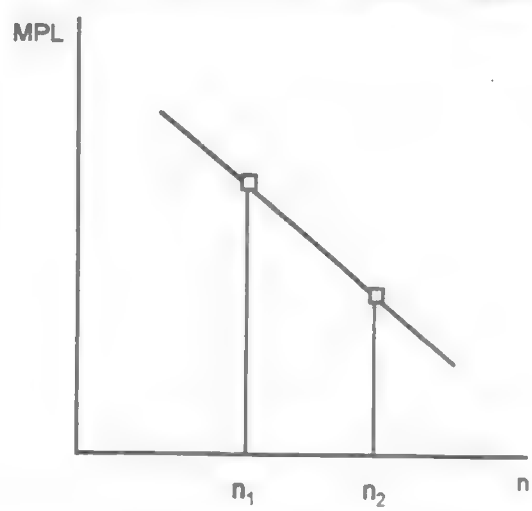
Graph of MPL vs labor hours



How do changes in technology affect output ? affect productivity ?

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- We make the assumption that an increase in technology enables each labor hour to be more productive (rotates the production function up).

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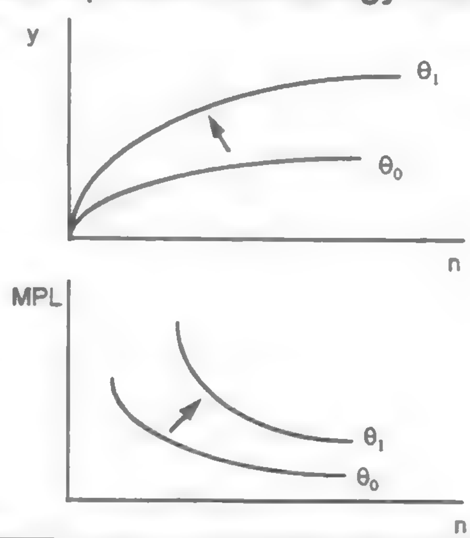
Impact of positive technology shock ($\theta_1 > \theta_0$)



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Part 2: Our model of demand

- The entrepeneur (or representative household) has preferences over consumption and leisure captured by a utility function.
- The entrepeneur likes to consume but dislikes work (I'd rather be paid for vacationing) represented by U(c,n).

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How do we represent preferences graphically ?

- An indifference curve is the set of combinations of consumption, c_t, and labor, n_t, that provide the household with equal levels of utility.
- The slope of the indifference curve is sometimes called the marginal rate of substitution (MRS).

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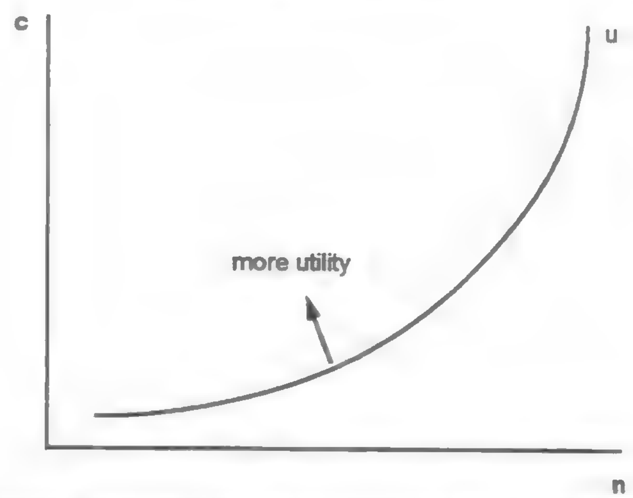
Indifference curve



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What accounts for the indifference curve's upward slope ? for its increasing slope ?

- To induce the entrepeneur to work more, she must be compensated with extra consumption to keep her at the same level of utility.

- While the compensation may be small at low levels of work, it must be high to induce her to work when she's already tired (i.e. at high levels of work).

The changing slope of the indifference curve: the entrepeneur must be compensated more and more to work extra hours

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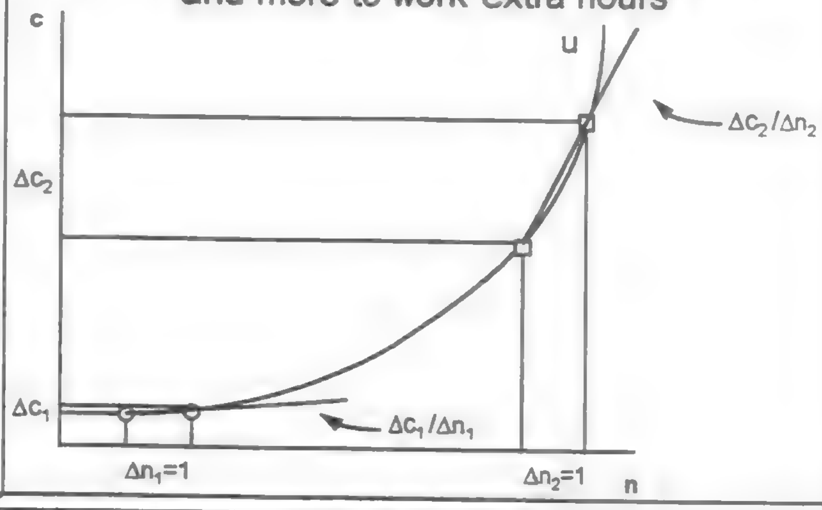

Putting supply and demand together: Equilibrium

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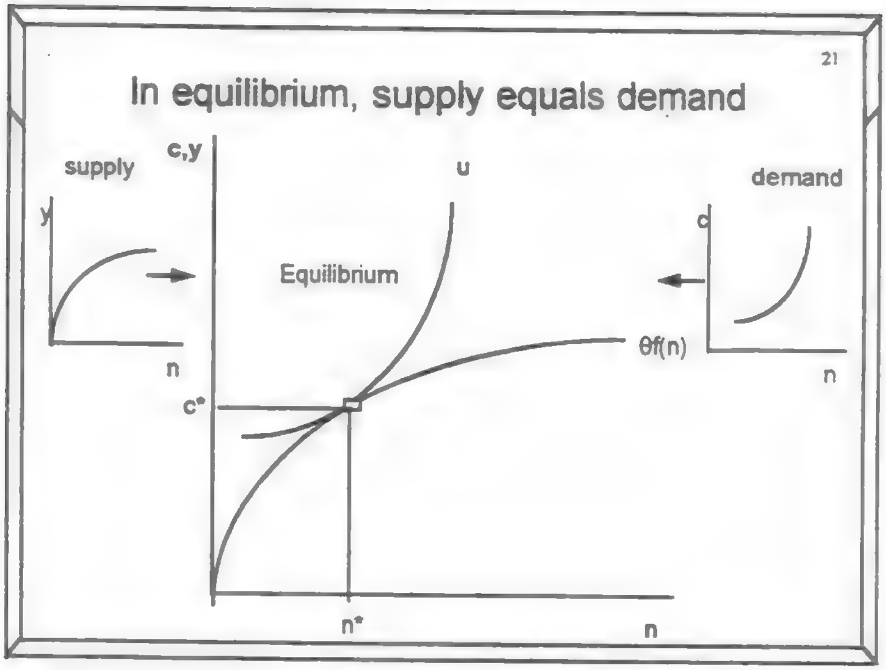
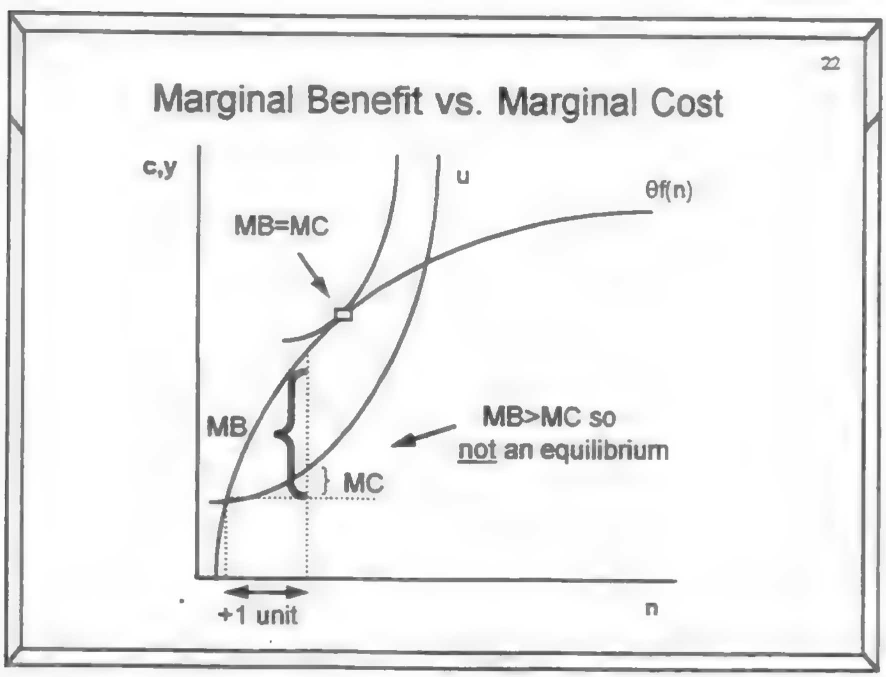
- At an equilibrium, the entrepeneur maximizes her utility subject to her production possibilities.
- A way to characterize an equilibrium is to note that the marginal benefit of working an extra hour (the MPL) equals the marginal (utility) cost of working (the utility value of one hour of lost leisure time given by the MRS).


21
In equilibrium, supply equals demand
supply
c,y
u
demand
y
c
Equilibrium
θf(n)
n
n
c*
n*
n


22
Marginal Benefit vs. Marginal Cost
c,y
u
θf(n)
MB=MC
MB
MB>MC so
not an equilibrium
} MC
+1 unit
n

What happens to output and aggregate hours if there is a technology shock ?

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- An increase in the state of the technology results in
  - increased real output
  - increased real consumption
  - increased labor hours (under some conditions)

We assume the economy was in equilibrium before the shock

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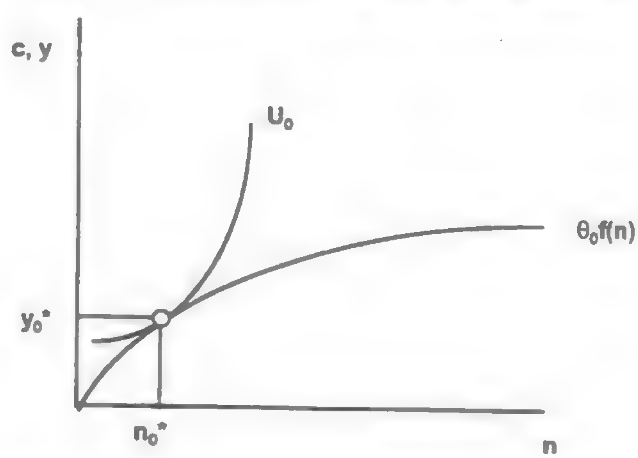
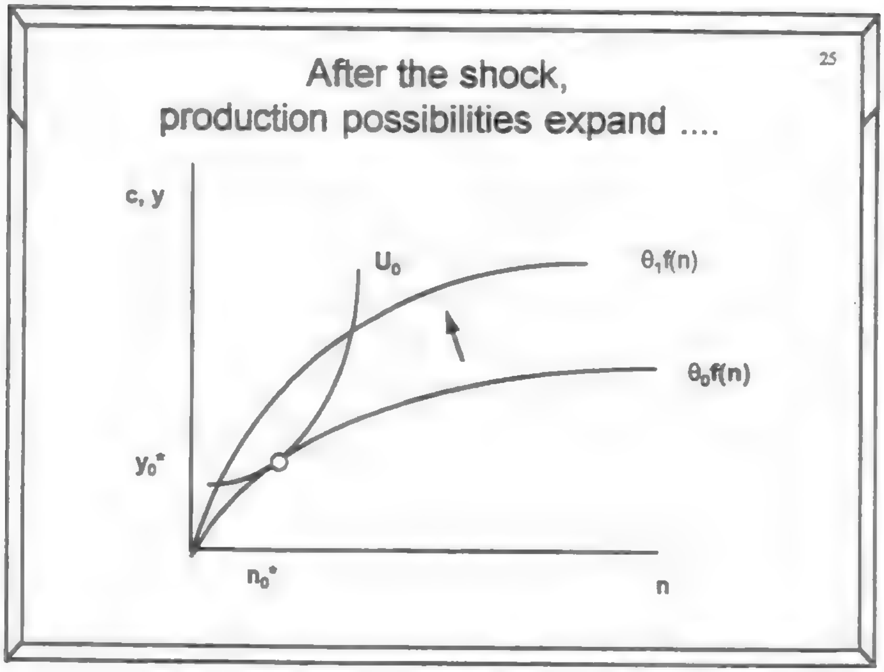
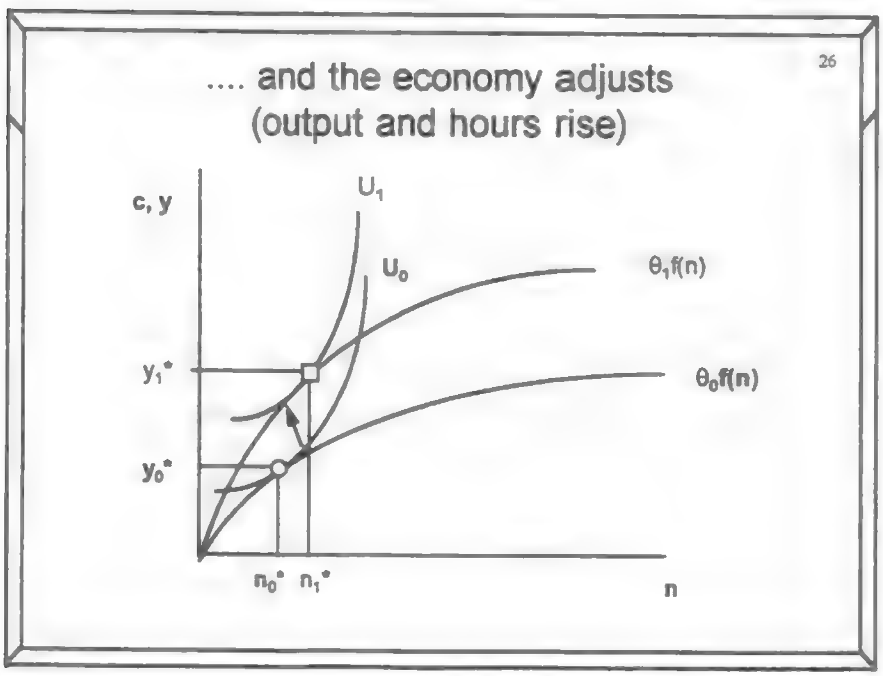



25
After the shock,
production possibilities expand ....
c, y
U_0
$\theta_1 f(n)$
$\theta_0 f(n)$
y_0^*
n_0^*
n


26
.... and the economy adjusts
(output and hours rise)
c, y
U_1
U_0
$\theta_1 f(n)$
$\theta_0 f(n)$
y_1^*
y_0^*
n_0^* n_1^*
n

Is it clear that labor hours should increase ?

- While labor is more productive (and the entrepeneur should "substitute" into it), the entrepeneur already earns more "income" for every existing hour she works. Hence, she may decide to work less.
- We call these competing forces "income" and "substitution" effects.

Who would work more hours if I raised their hourly wage ? Who would work less ?

- If you answer more, then economists say your preferences reflect dominant substitution effects.
- If you answer less, then your preferences reflect dominant income effects.

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On the decomposition of income and substitution effects

- The income effect: we see this as a parallel shift of the production function.

- The entrepeneur spends the increase in income on both goods (consumption and leisure).

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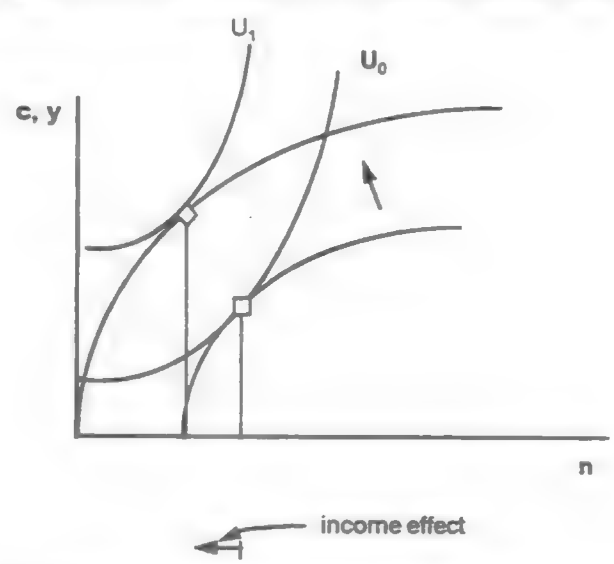

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- The substitution effect: we see this as a rotation of the MPL along the original indifference curve.

- The increase in MPL (or real wage) means that the marginal benefit of working an extra hour exceeds the marginal utility loss of working the extra hour, so the entrepeneur <u>substitutes</u> out of leisure.

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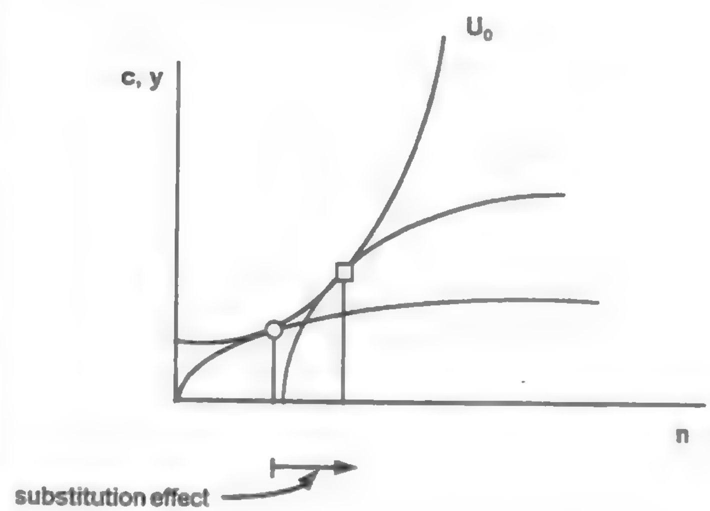

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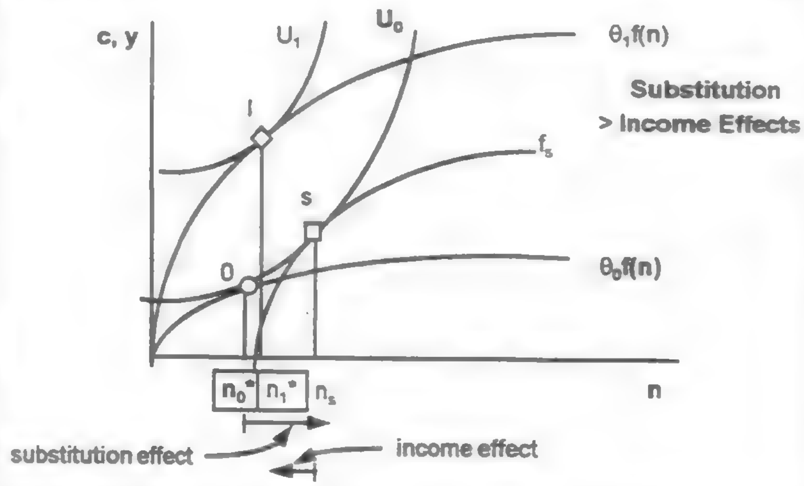
Putting substitution and income effects together



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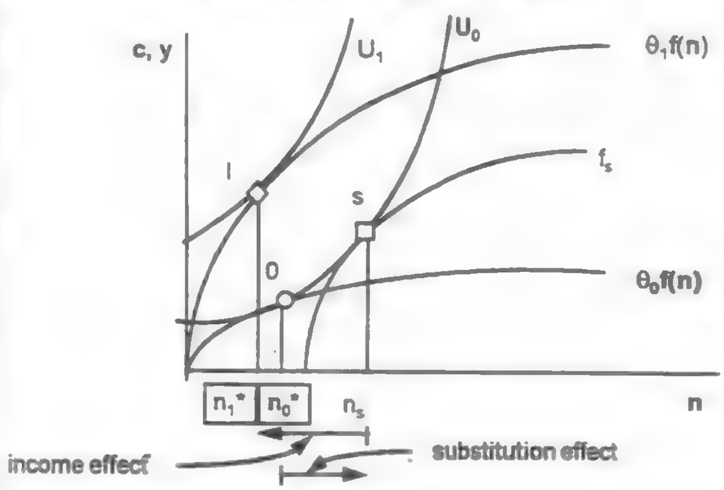
What if income effects dominate substitution effects ?



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What does the data say ?

- The data suggests that the APL is mildly pro-cyclical.
- Since the data suggests that APL(=y/n) rises, but not as much as output, this provides some evidence that preferences tend to exhibit dominant substitution effects.

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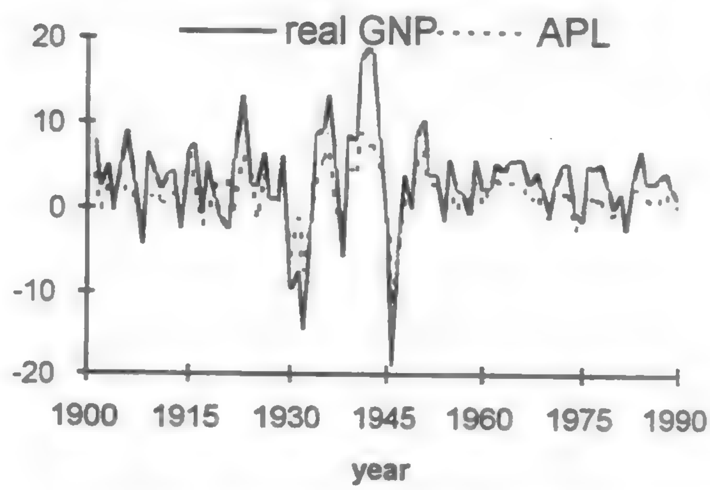

Growth rate of Real GNP and APL

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How do we measure technological change ?

- Measuring technological change is difficult, so we "back out" a measure of technological change from the data that is called the Solow residual

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On a measure of technological change

- Output is given by the production function:

$$y_t = \theta_t \cdot f(n_t, \text{other factors}(z_t))$$

- So the sources of changes in output are:
  - changes in technology (θ_t)
  - changes in labor hours (n_t)
  - changes in other factors (z_t) such as capital, etc.

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- With a particular production function:

$$y_t = \theta_t n_t^{\alpha} z_t^{1-\alpha}$$

- The decomposition is given by:

$$\frac{\Delta y_t}{y_t} = \frac{\Delta \theta_t}{\theta_t} + \alpha \frac{\Delta n_t}{n_t} + (1-\alpha)\frac{\Delta z_t}{z_t}$$

- Then given data on real output growth, the growth rate of labor hours and other factors, we can "back out" technological change.

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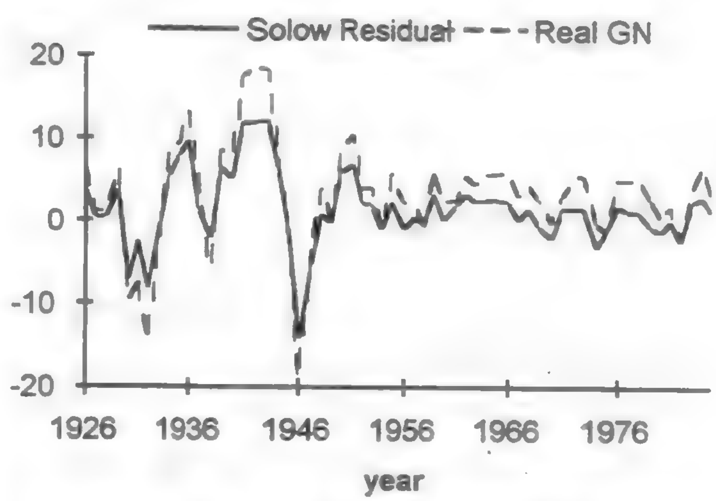


Growth rate of Solow Residual and Real GNP

Question 2

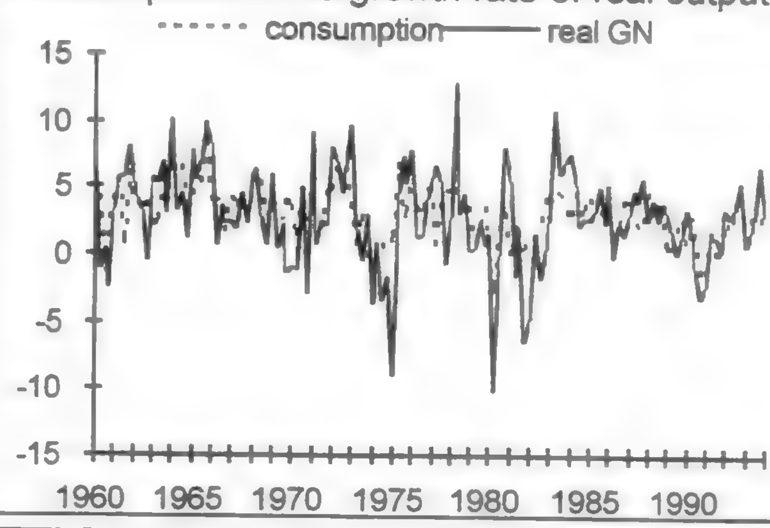
- 8 of the last 9 recessions have occured at the same time or immediately followed oil price increases (Auerbach & Kotlikoff (1995) p.369.
- A rapid increase in the price of oil, an input into the production function, may cause firms to change their technologies.
- Suppose θ_t falls in response to an oil price rise. What happens to output, labor hours, and productivity?

1

The Smoothing of Fluctuations over Time

2

Which is smoother, the growth rate of consumption or the growth rate of real output ?



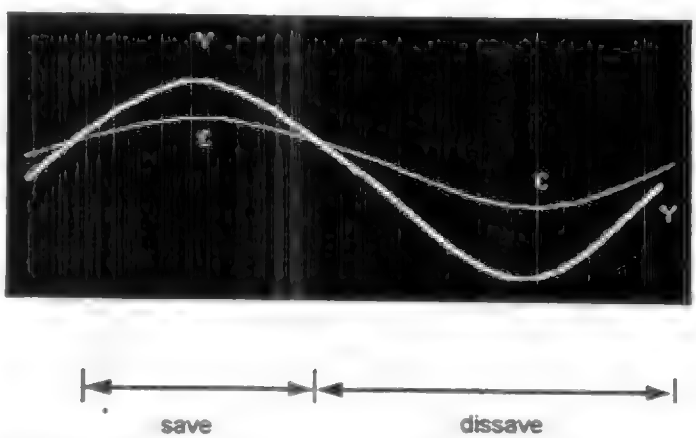
Which one has higher variance ? Is consumption growth procyclical ?

3

- The variance of real GDP growth is 13 while the variance of consumption growth is 4, another indication that consumption is smoother than GDP
- The growth rates of real GDP and consumption are not prefectly correlated (which was predicted in the previous version of our model). Consumption growth is procyclical (the correlation coefficient with real GDP is 0.56).

What accounts for the difference? Aggregate Saving and Dissaving

4



A bond market allows a household's current consumption to differ from its current income

5

- With bonds, households can save or borrow.
- We will focus on the determinants of saving or borrowing at the individual level:
  - Preferences for present vs. future consumption
  - Fluctuations in present income and expectations about future income
- Note: Bond markets don't help us understand aggregate saving and dissaving.

A simple bond market

6

- Our concept of a bond is a one period IOU to goods (rather than money).
- A lender gives up b_t units of current (period t) goods in return for $(1+r_t)b_t$ units of future (period t+1) goods. The lender is a current demander of IOUs (i.e. $b_t > 0$).
- A borrower gives up $(1+r_t)b_t$ units of future (period t+1) goods in return for b_t current goods. The borrower is a current supplier of IOUs (i.e. $b_t < 0$).

7

The Household Budget Constraint

- A budget constraint simply relates the sources of funds to the uses of funds.
- In the simple model of the previous chapter, the only source of funds was the entrepeneur's income (y_t) and she had no option but to consume (c_t) the non-storable good. That is:

$$c_t = y_t$$

(uses of funds) (sources of funds)

8

- With a bond market, the budget constraint is now:

$$c_t + b_t = y_t + (1+r_{t-1})\, b_{t-1}$$

(uses of funds) (sources of funds)

where r_{t-1} is the real interest rate from t-1 to t.
- The household sources of funds are current income <u>and</u> any previous lending (sources are depleted if you were a borrower, $b_{t-1} < 0$).
- The uses of funds are consumption and/or new bond market transactions (Note: $b_t < 0$ is a source of current funds).

Bonds provide the intertemporal link in the household budget constraint

9

Budget constraint at t : $c_t + b_t = y_t + (1+r_{t-1})\, b_{t-1}$

$$c_{t+1} + b_{t+1} = y_{t+1} + (1+r_t)\, b_t$$ Budget constraint at t+1

The Intertemporal Budget Constraint

10

- If the household begins and ends with no debt or claims ($b_{t-1}=b_{t+1}=0$), then substituting b_t into both equations:

$$c_t + \frac{c_{t+1}}{1+r_t} = y_t + \frac{y_{t+1}}{1+r_t}$$

- This says that the present discounted value of expenditure equals the present discounted value of income.

11

How do we see the intertemporal budget constraint graphically ?

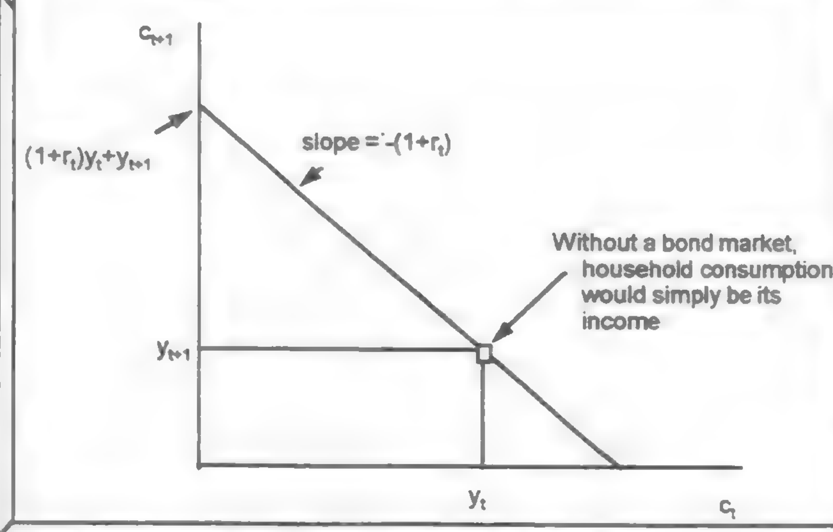
- The intertemporal budget constraint can be re-written as the equation of a line:

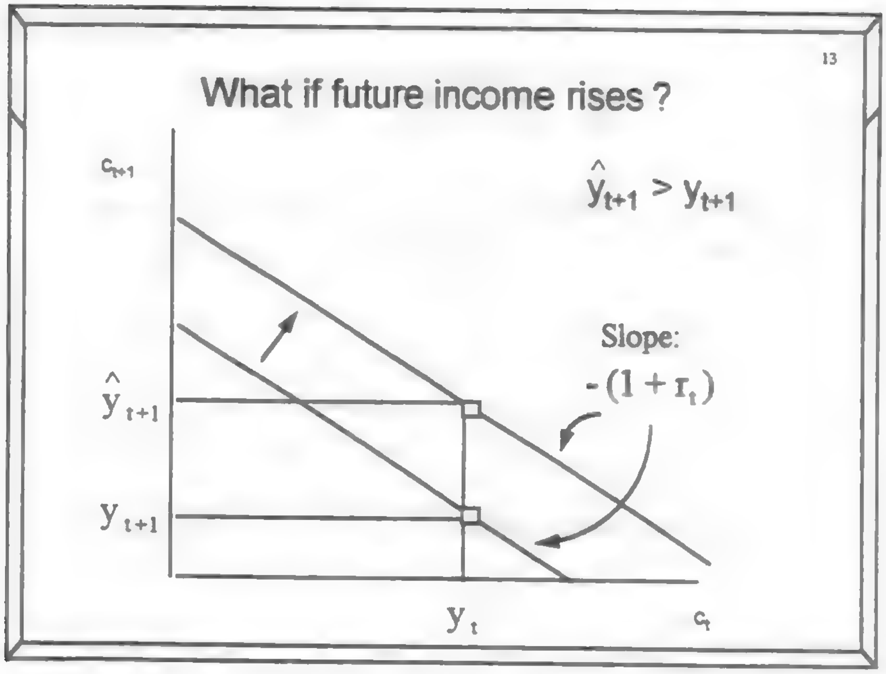
$$c_{t+1} = \underbrace{(1+r_t)\, y_t + y_{t+1}}_{\text{intercept}} \underbrace{-\,(1+r_t)}_{\text{slope}}\, c_t$$

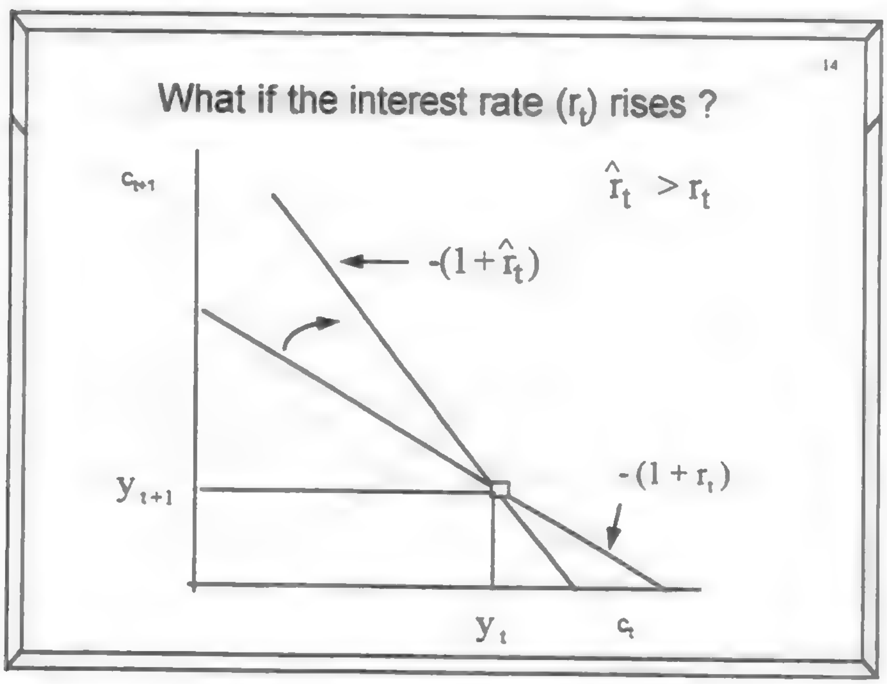
which we can graph in c_t and c_{t+1} space.

12

Graphing the intertemporal budget constraint




13
What if future income rises ?
c_{t+1}
$\hat{y}_{t+1} > y_{t+1}$
Slope:
$-(1 + r_t)$
$\hat{y}_{t+1}$
y_{t+1}
y_t
c_t


14
What if the interest rate (r_t) rises ?
c_{t+1}
$\hat{r}_t > r_t$
$-(1+\hat{r}_t)$
$-(1 + r_t)$
y_{t+1}
y_t
c_t

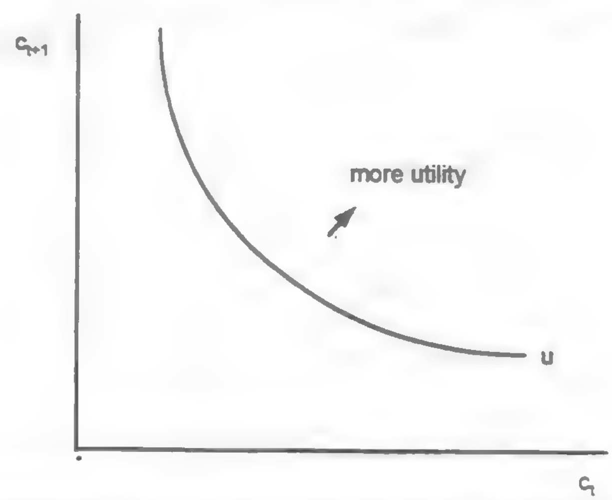
15

How does the household decide how much to consume today vs. the future ?

- To answer, we must know something about preferences.
- Again, preferences will be captured in a utility function, $U(\overset{+}{c_t}, \overset{+}{c}_{t+1})$, and represented by indifference curves.

16

Indifference curve for c_t and c_{t+1}



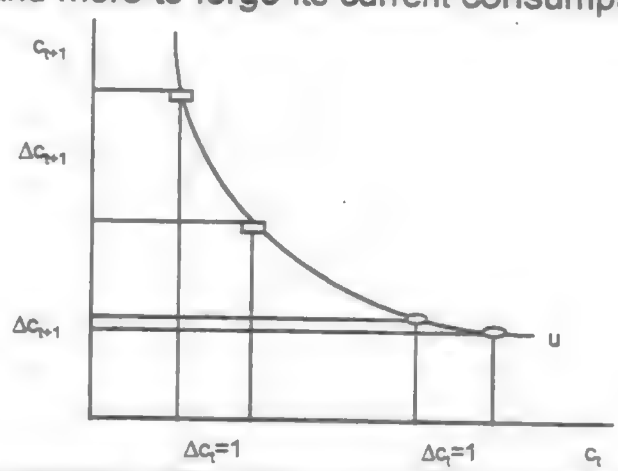
What accounts for the indifference curve's downward slope?
for its decreasing slope?

17

- To induce a household to consume less today, it must be compensated with extra future consumption to keep it indifferent.
- While the future compensation may be small at high levels of current consumption, future compensation must be high at low levels of current consumption (when its currently hungry).

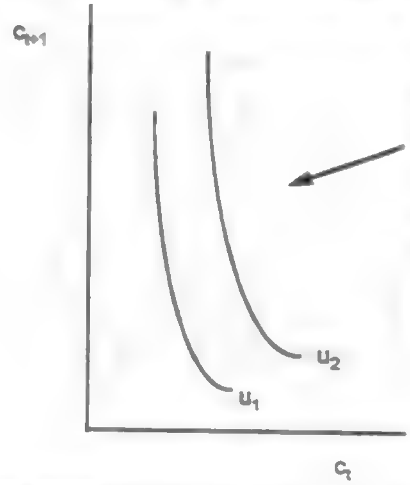
The changing slope of the indifference curve: a hungry consumer must be compensated more and more to forgo its current consumption

18



19

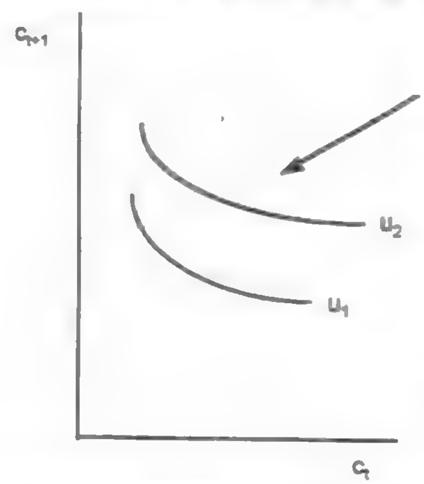
What does the indifference curve for an *impatient* individual look like ?



An impatient individual is willing to give up alot of future consumption for a unit increase in current consumption

20

What does the indifference curve for a *patient* individual look like ?



A patient individual is willing to give up very little future consumption for a unit increase in current consumption

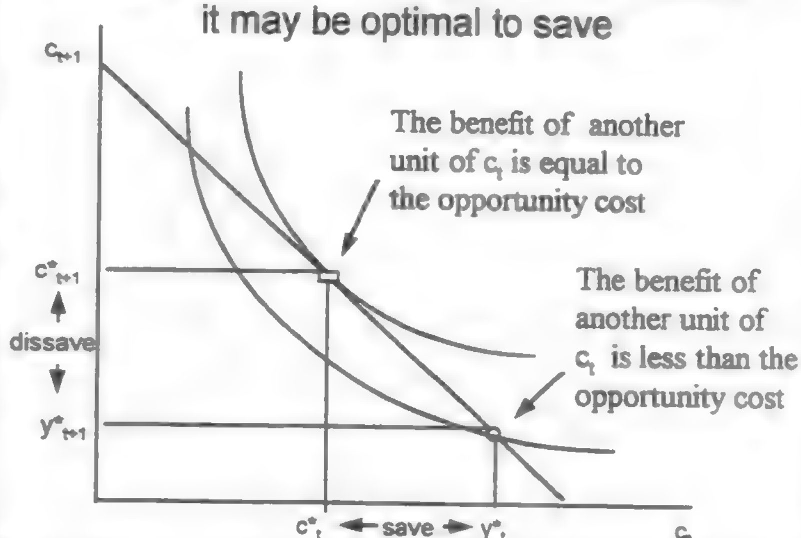
21

Putting Preferences and Budgets Together

- At the optimum, a household maximizes its utility subject to its intertemporal consumption possibilities.
- A way to characterize the optimum is to note that the marginal benefit to consuming one more unit today equals the marginal cost (or the opportunity cost of not saving; i.e. the gross real return $(1+r_t)$).

22

For an individual with high current income, it may be optimal to save



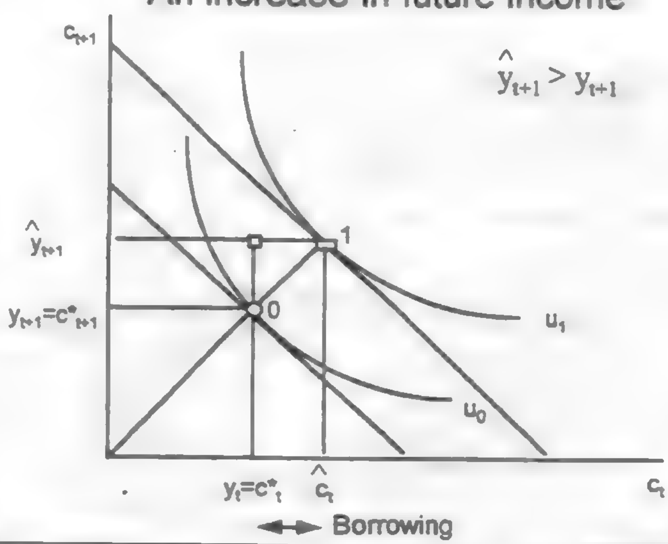
23

What happens to saving if future income is expected to rise ?

- Households borrow against their future income in order to spread their consumption more smoothly (i.e. current consumption rises).

24

An increase in future income

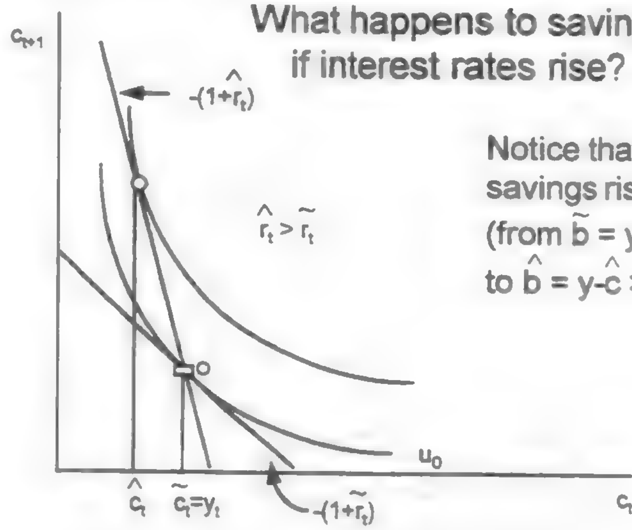


25

Consumer confidence and borrowing
p. A2, WSJ 3-30-94

"Consumers are borrowing heavily again signaling optimism about the future"
p.C1, WSJ 3-30-94

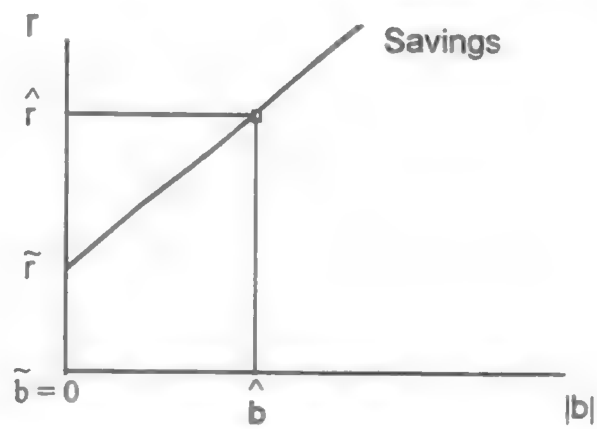
What happens to saving if interest rates rise?

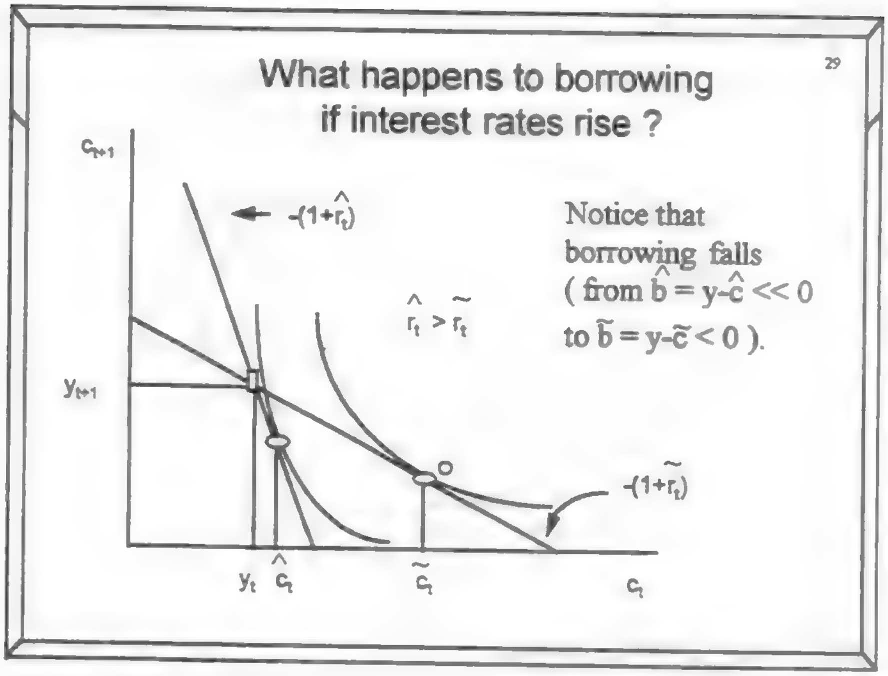


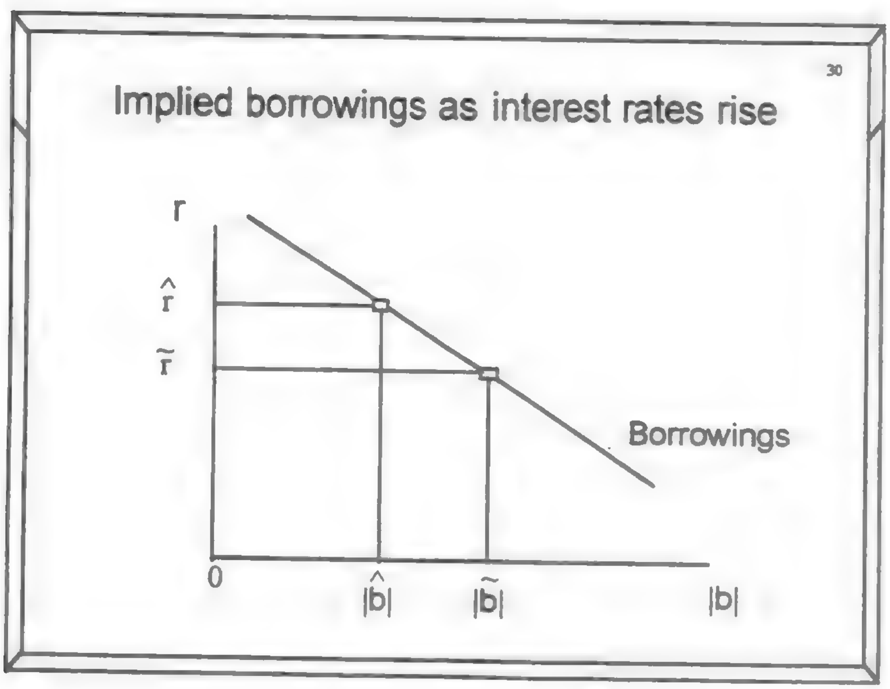
Notice that savings rise (from $\tilde{b} = y - \tilde{c} = 0$ to $\hat{b} = y - \hat{c} > 0$)

$\hat{b}_t = y_t - \hat{c}_t > 0$

Implied savings in bonds as interest rates rise (assuming dominant substitution effects)




29
What happens to borrowing
if interest rates rise ?
c_{t+1}
$-(1+\hat{r}_t)$
Notice that
borrowing falls
(from $\hat{b} = y-\hat{c} << 0$
to $\tilde{b} = y-\tilde{c} < 0$).
$\hat{r}_t > \tilde{r}_t$
y_{t+1}
$-(1+\tilde{r}_t)$
y_t $\hat{c}_t$
$\tilde{c}_t$
c_t


30
Implied borrowings as interest rates rise
r
$\hat{r}$
$\tilde{r}$
Borrowings
0
$|\hat{b}|$
$|\tilde{b}|$
$|b|$

31

In summary, what happens to saving (or borrowing) if interest rates rise ?

- An increase in interest rates has both income and substitution effects.
- Any existing unit saved earns the saver more interest income. Any existing unit borrowed costs the borrower more interest income.
- The marginal (opportunity) cost of consuming today rises, so both savers and borrowers should lower current consumption (substitute out of current into future consumption).

32

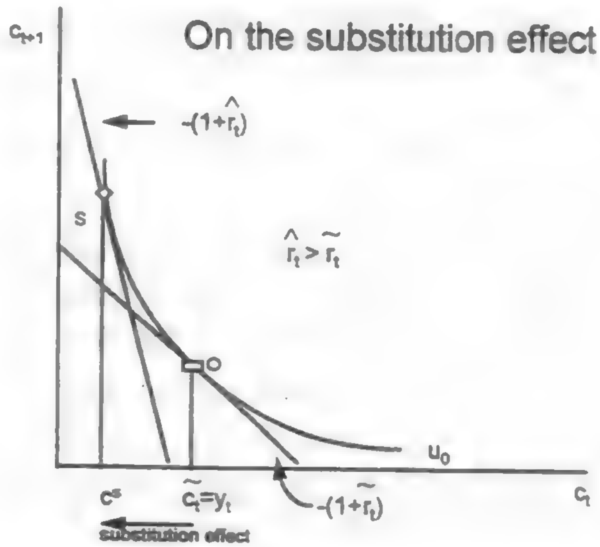
More on the decomposition of income and substitution effects

- The substitution effect: we see this as a rotation of the intertemporal budget constraint along the original indifference curve.

- The increase in interest rates means that the opportunity cost of consuming an extra unit today exceeds the marginal utility gain, so households consume less today.

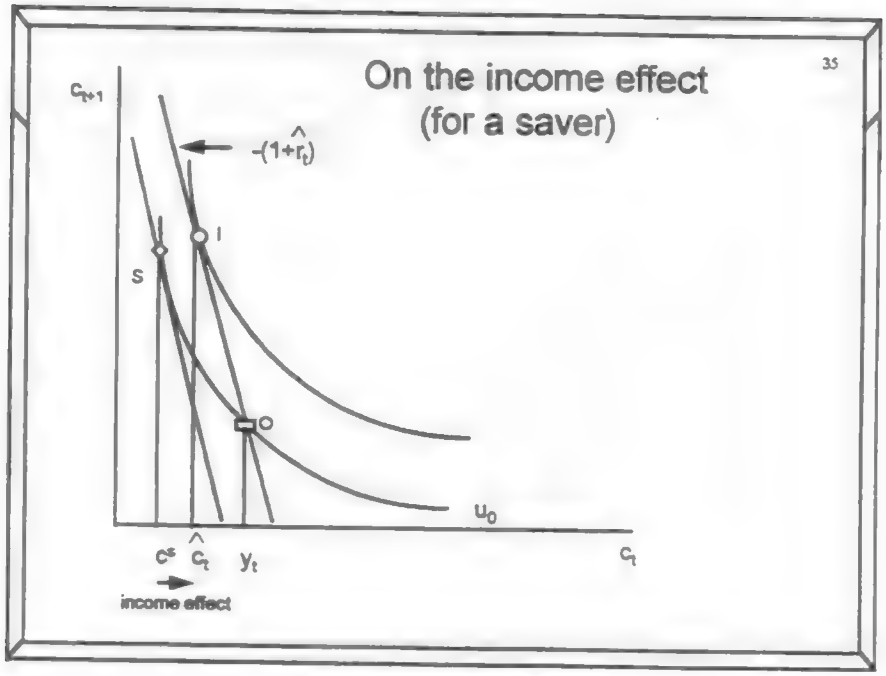
33

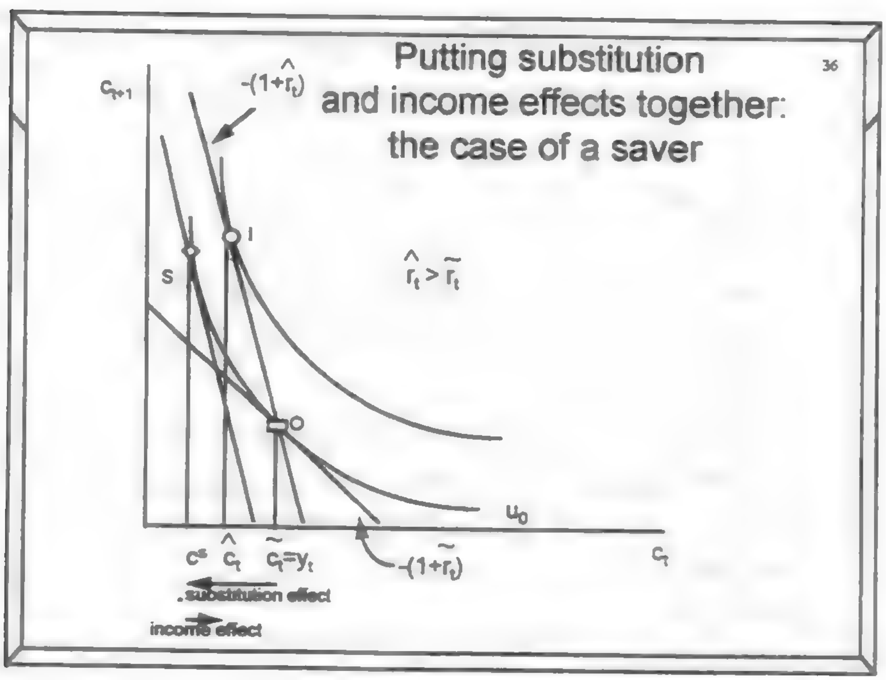
On the substitution effect



34

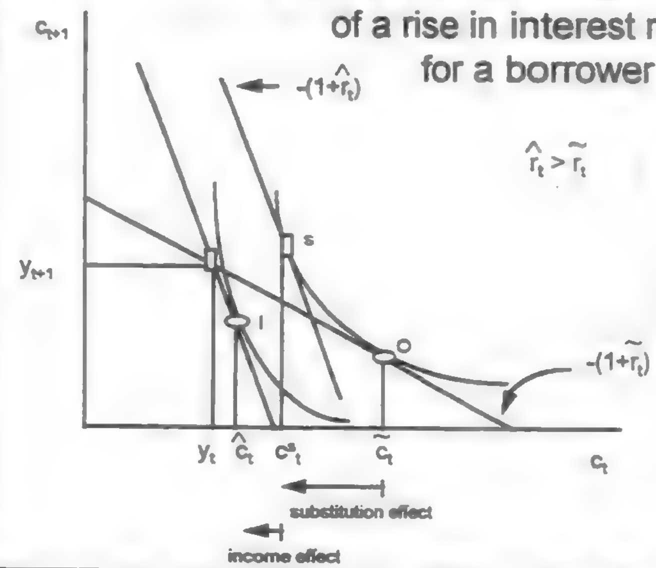
- The income effect:
  - The saver increases current consumption out of the increase of income.
  - The borrower decreases current consumption due to the decrease in income.


On the income effect
(for a saver)
35
c_{t+1}
$-(1+\hat{r}_t)$
I
S
O
u_0
c^s $\hat{c}_t$ y_t
c_t
income effect


Putting substitution
and income effects together:
the case of a saver
36
c_{t+1}
$-(1+\hat{r}_t)$
I
S
$\hat{r}_t > \tilde{r}_t$
O
u_0
c^s $\hat{c}_t$ $\tilde{c}_t = y_t$
$-(1+\tilde{r}_t)$
c_t
substitution effect
income effect

Income and substitution effects of a rise in interest rates for a borrower

37



Would capital gains tax cuts actually raise the total level of savings? p.68, The Economist, 1-21-95

38

- "A higher return on savings, thanks to a tax break, should encourage people to save more (it becomes more attractive to swap future for current consumption): this is the so-called substitution effect."
- "On the other hand, this could be offset by an income effect; a higher return on savings means that individuals can achieve their desired future consumption with lower savings."

Would capital gains tax cuts
actually raise the total level of savings?
p.68, The Economist, 1-21-95

39


Whatever happened to that rainy day?

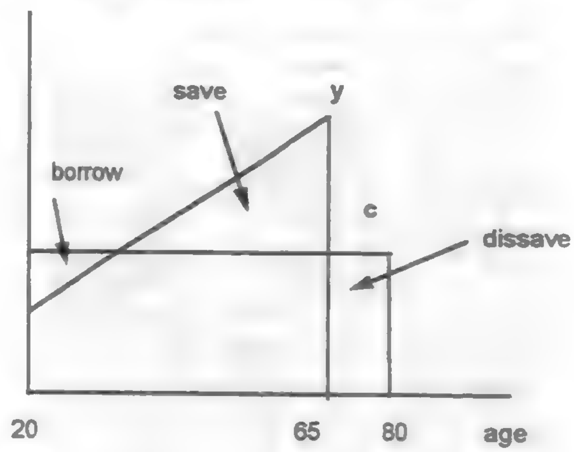
In summary,
why do bond markets exist ?

40

- Bond markets exist because agents are not all the same, there are differences in
  - life-cycle (young agents save,
    old agents dissave)
  - time preference (patient save,
    impatient borrow)

41

The Life-cycle is one reason why bond markets exist



42

How does the labor supply decision of households vary over time ?

- A self-employed household maximizes utility by choosing how much to consume and work in each period:

$$\max \quad U(c_t, c_{t+1}, n_t, n_{t+1})$$

$$\text{s.t.} \quad c_t + \frac{c_{t+1}}{1+r_t} = \theta_t f(n_t) + \frac{\theta_{t+1} f(n_{t+1})}{1+r_t}$$

43

What happens to labor supply if there is an increase in r_t ?

$$c_t + \frac{c_{t+1}}{1+r_t} = \theta_t f(n_t) + \frac{\theta_{t+1} f(n_{t+1})}{1+r_t}$$

- The discount factor, $1/1+r_t$, has decreased, therefore future work effort is worth less and the household will work more currently and work less in the future; i.e. $n_t(\overset{+}{r_t}; \theta_t, \theta_{t+1})$

44

An alternative interpretation

- The opportunity cost of future leisure has fallen relative to the opportunity cost of current leisure, so the household substitutes out of current leisure into future leisure.

- If the household can save out of its current work effort, then higher interest rates induce it to work and save more.

What happens to labor if there is an increase in θ_t ? 45

$$c_t + \frac{c_{t+1}}{1+r_t} = \theta_t f(n_t) + \frac{\theta_{t+1} f(n_{t+1})}{1+r_t}$$

- Productivity in period t increases relative to period t+1, so the agent works more in the current period and works less in the future; i.e. $n_t (r_t; \overset{+}{\theta}_t, \theta_{t+1})$.

What happens to labor if there is an increase in θ_{t+1} ? 46

$$c_t + \frac{c_{t+1}}{1+r_t} = \theta_t f(n_t) + \frac{\theta_{t+1} f(n_{t+1})}{1+r_t}$$

- Productivity in the future increases relative to the present, so the agent works more in the future and works less today (rest up for a big push) ; i.e. $n_t (r_t; \theta_t, \overset{-}{\theta}_{t+1})$.

47

What are the impact effects of a current productivity increase ?

- Current labor supply increases.
- The increase in current income is spent on consumption in both periods. Current consumption increases by less than the increase in current income.
- Bonds are purchased to save current income for future consumption.

48

What are the impact effects of a rise in consumer confidence ?

- Consumption in the present period increases because lifetime income is expected to increase.
- This increased consumption is financed by increased borrowing.
- Current labor hours will decrease depending on the perceived increase in θ_{t+1}.

A "General" concept of equilibrium

- These impact effects do not take into account what will happen to interest rates as productivity changes.
- To study interest rate changes, we need a general equilibrium (the interrelation of goods and bond markets).

1C

1

The Determination of Real Interest Rates

2

How is the interest rate determined ?

- Until now we have analyzed demand and supply functions; that is, how quantities such as consumption, labor supply, and bond holdings are determined as a function of price (the price being the real interest rate).
- Now we must determine price.

3

The interrelationship of markets

- Partial equilibrium analysis examines a market in isolation.
- General equilibrium analysis examines the interrelation of markets (spillovers).
- We now look for the general equilibrium of a simple two market economy (a goods market and a bond market) and determine one price (the real interest rate).

4

Define market clearing for our two markets

- For the goods market, market clearing is where supply equals demand:

$$C_t \equiv \sum_{j=1}^{J} c_t^j = \sum_{j=1}^{J} y_t^j \equiv Y_t^s,$$

- For the bond market, market clearing is where the supply of IOUs (borrowing, b<0) equals the demand for IOUs (saving, b>0):

$$\sum_{j=1}^{J} b_t^j = 0$$

5

What is the relation between market clearing and individual budget balance ?

- For any individual (agent j)

$$c_t^j + b_t^j = y_t^j + (1+r_{t-1})\, b_{t-1}^j$$

- Summing over all J agents

$$\sum_{j=1}^{J} b_t^j = \sum_{j=1}^{J} (y_t^j - c_t^j) + (1+r_{t-1}) \sum_{j=1}^{J} b_{t-1}^j$$

6

In the 2 market case, goods market clearing implies bond market clearing since:

$$\sum_{j=1}^{J} b_t^j = Y_t - C_t + (1+r_{t-1}) \sum_{j=1}^{J} b_{t-1}^j$$

- Goods market clearing is $Y_t - C_t = 0$ and bond market clearing in t-1 is $\Sigma_j\, b^j_{t-1} = 0$, so the bond market must clear in t, i.e. $\Sigma_j\, b^j_t = 0$.
- Mathematically, there's only 1 independent equation.

7

This result is known as Walras' Law

- Walras' Law states that if there are n markets and there is market clearing in n-1 of them, then the nth market clears as well.

- There are two practical implication of Walras' Law in the (n=2) model we now consider:
  - we need only analyze goods market clearing to know something about bond market clearing.
  - we need only consider one price (r_t).

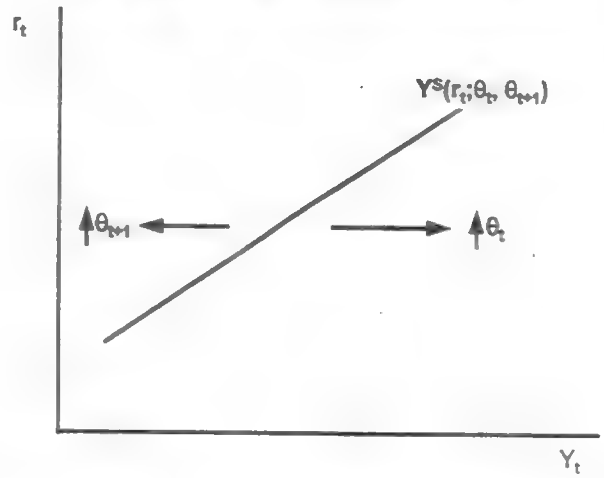
8

What factors influence aggregate supply?

- Real interest rates (r_t): affect labor hours by changing the intertemporal value associated with labor (recall $n_t(\overset{+}{r_t}\,;\, \theta_t, \theta_{t+1})$).
- Technological change: θ_t has a direct effect on the production function and both θ_t and θ_{t+1} have indirect effects on labor hours (recall $n_t(r_t\,;\, \overset{+}{\theta_t}, \overset{-}{\theta_{t+1}})$).
- Since technology and labor are elements of the production function, then $Y^s_t(\overset{+}{r_t}\,;\, \overset{+}{\theta_t}, \overset{-}{\theta_{t+1}})$.

9

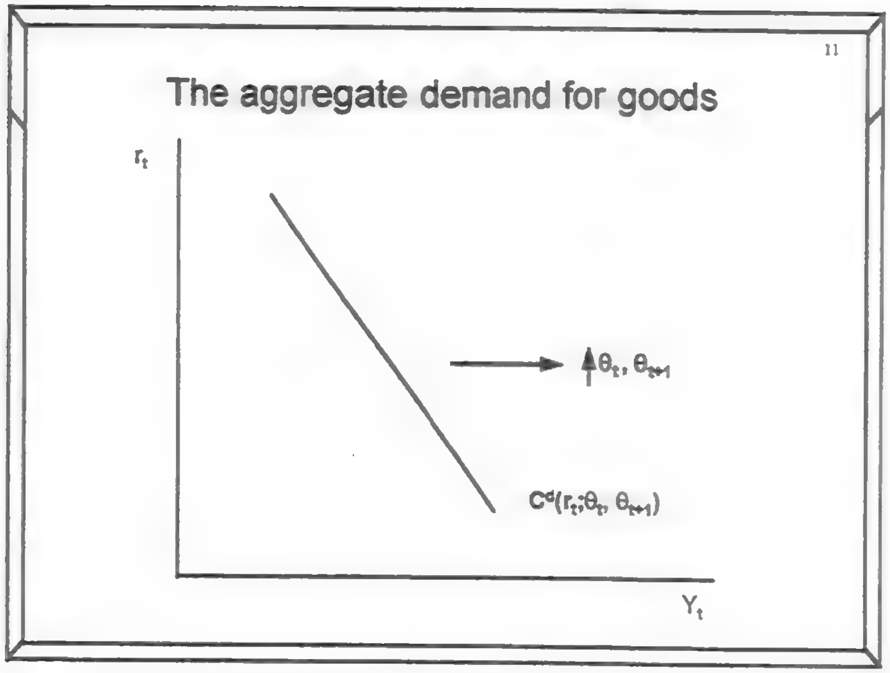
The aggregate supply of goods

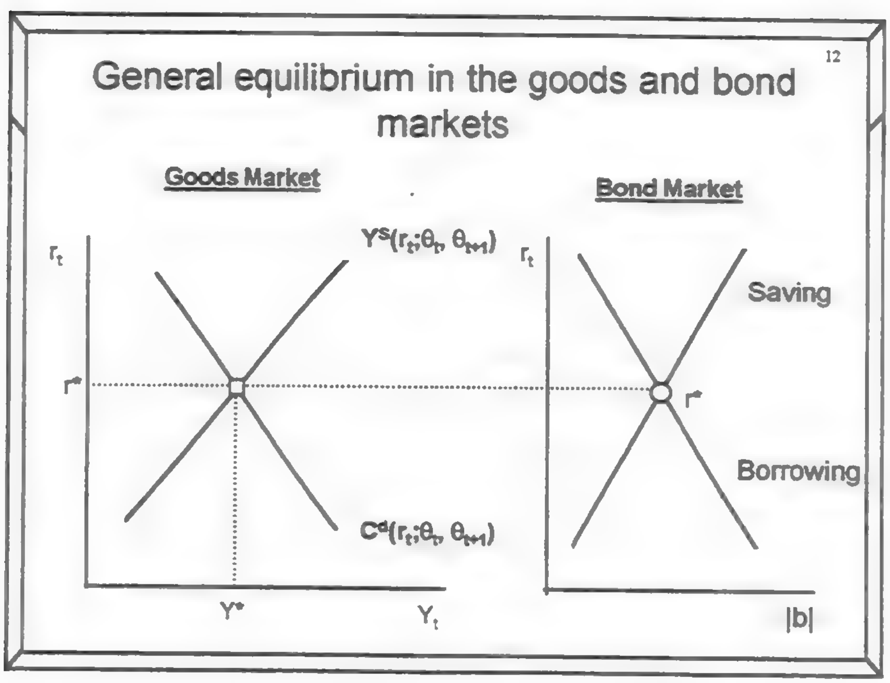


10

What factors influence aggregate demand?

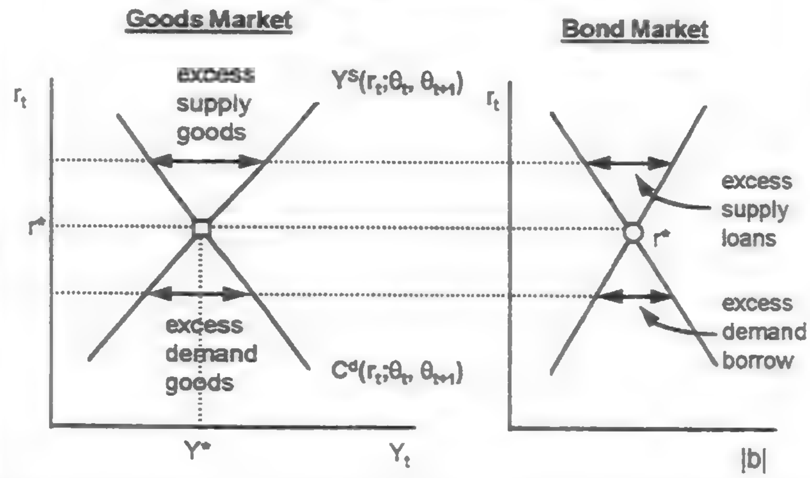
- Real interest rates (r_t): affect consumption by changing the opportunity cost of present vs. future consumption (recall $c_t(\overset{-}{r}_t;\ \theta_t, \theta_{t+1})$).
- Technological change: θ_t and θ_{t+1} affect current and future real income; households consume from PDV of income ($c_t(r_t;\ \overset{+}{\theta}_t, \overset{+}{\theta}_{t+1})$).
- For now, aggregate demand is the sum of household consumption ($Y^d_t(\overset{-}{r}_t;\ \overset{+}{\theta}_t, \overset{+}{\theta}_{t+1})$).


11
The aggregate demand for goods
r_t
$\uparrow \theta_t, \theta_{t+1}$
$C^d(r_t;\theta_t, \theta_{t+1})$
Y_t


12
General equilibrium in the goods and bond markets
Goods Market
Bond Market
$Y^S(r_t;\theta_t, \theta_{t+1})$
r_t
Saving
r^*
Borrowing
$C^d(r_t;\theta_t, \theta_{t+1})$
Y^*
Y_t
$|b|$

13

What happens if we move away from the equilibrium interest rate ?



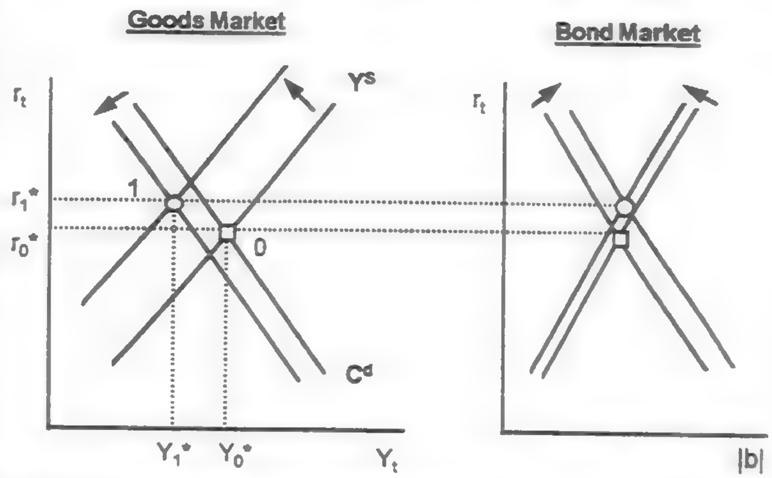
14

How does the interest rate change with the business cycle ?

- If there is a temporary, negative technology shock, such as the oil price shocks of the 1970s, then
  - on the supply side, as $\theta_t \downarrow \Rightarrow Y_t \downarrow$ (goods market supply curve shifts left)
  - on the demand side, as $\theta_t \downarrow \Rightarrow C_t \downarrow$ (goods market demand curve shifts left, but not as much as the supply curve since consumers will borrow to smooth shock)

15

Effects of a temporary, negative technology shock



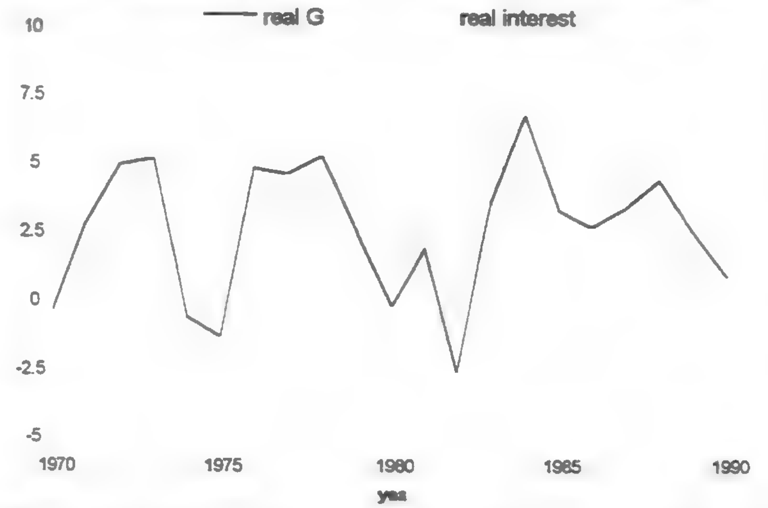
16

Interest rates and output fluctuations

- If the shock is expected to be temporary, then households will want to smooth the downturn in their income by borrowing (or dissaving). Excess borrowing in the bond market raises the real interest rate.
- This can also been seen in the goods market, where the excess demand for goods is choked off by higher interest rates.
- Prediction of the simple model: real interest rates are mildly countercyclical (will change).

17

Growth rate of real GDP and real interest rate



18

The distinction between real and nominal

- The real interest rate is the relative price of future goods in terms of current goods. It's typically positive because, all else equal, I would rather consume today than tomorrow.

- Since virtually all transactions in the WSJ are listed in nominal terms, we now introduce money into our model.

1

The Portfolio Decision with Money and the Determination of the Aggregate Price Level

2

The Money Market

- Since virtually all prices are quoted relative to a currency, we now study the money market.
- Who trades in the money market ?
  - Households (and firms) demand money.
  - The Federal Reserve Bank supplies money.

3

How does money enter the household's portfolio decision ?

- The budget contraint in nominal terms

$$P_t c_t + P_t b_t + m_t = P_t y_t + P_t (1+r_{t-1})\, b_{t-1} + m_{t-1}$$

where P_t is dollars per consumption good,
$m_t \geq 0$ is dollars held at time t,
all else defined as before.

4

The intertemporal budget constraint with money

- Simply, let $b_{t-1}=0=b_{t+1}$ & $m_{t-1}=0=m_{t+1}$. Then the current and future constraints in real terms:

$$\text{SBC}_t \qquad c_t + b_t + \frac{m}{P_t} = y_t$$

$$\text{SBC}_{t+1} \qquad c_{t+1} = y_{t+1} + (1+r_t)b_t + \frac{m}{P_{t+1}}$$

- Substituting for b_t, gives the intertemporal constraint:

$$c_t + \frac{c_{t+1}}{1+r_t} = y_t + \frac{y_{t+1}}{1+r_t} - \frac{m_t}{P_t}\left(1 - \frac{P_t}{P_{t+1}(1+r_t)}\right)$$

5

$$c_t + \frac{c_{t+1}}{1+r_t} = y_t + \frac{y_{t+1}}{1+r_t} - \ldots$$

- This part looks exactly as before.

$$\ldots - \frac{m_t}{P_t}\left(1 - \frac{P_t}{P_{t+1}(1+r_t)}\right)$$

- This part is new.
- Since $m_t/p_t > 0$, if the term in parenthesis is > 0 , then the sources of funds is reduced by holding "idle" money.

6

What is the term in parenthesis ?

- Using the defn of inflation, $(P_{t+1}/P_t = (1+\pi_t))$, and the defn of nominal interest rates , $((1+R_t) = (1+\pi_t)(1+r_t))$, the term in parenthesis is

$$1 - \frac{1}{(1+R_t)}$$

which is >0 provided $R_t > 0$.
- This simpliy says with a positive opportunity cost of holding money, its portfolio holding should be small.

7

If money is not a good store of value, why do agents hold money ?

- Money is used as a medium of exchange that enables agents to avoid a double coincidence of wants (e.g. waiting on a NYC corner for a cab that wants an economics lesson).

- Agents hold money to facilitate transactions but attempt to minimize the opportunity costs associated with holding money in their portfolio, balanced against brokerage fees of cash management.

8

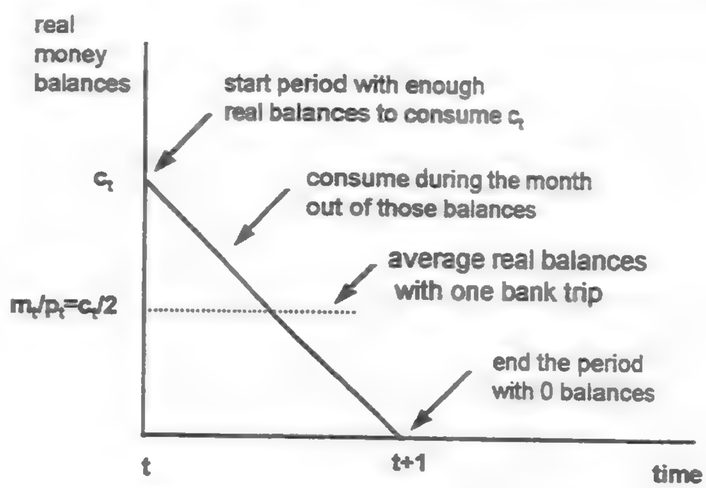
One approach to cash management

- Receive nominal income, $P_t y_t$, at the beginning of the month deposited directly into interest earning account.
- Cash it, incurring a brokerage fee $P_t \gamma$.
- Use the resulting cash balance to purchase consumption throughout the period.
- Average real money balances for one transaction, ($\eta = 1$),

$$\frac{m_t}{P_t} = \frac{c_t}{2 \cdot 1}$$

9

Average cash balances for one transaction



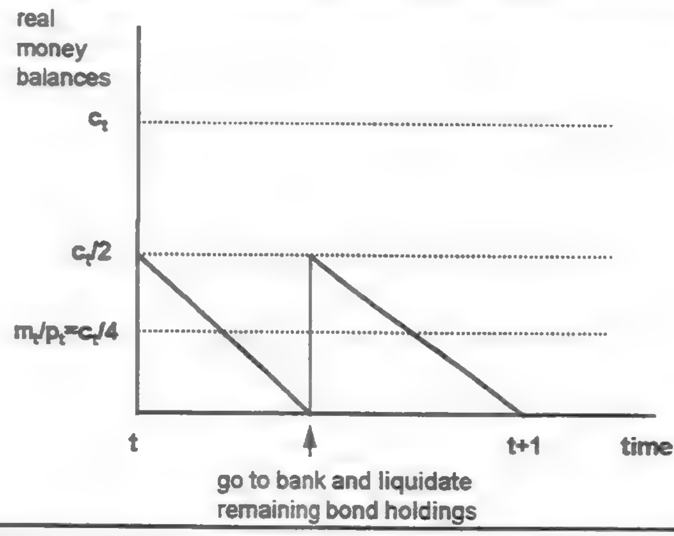
10

Another approach to cash management

- Cash half of your nominal paycheck, incurring the brokerage fee $P_t\,\gamma$.
- Use the resulting cash balance to purchase consumption for the first half of the period.
- Cash the rest of the paycheck midperiod, incurring another brokerage fee, and consume the second half.
- Average real money balances for two transactions, (η = 2), $\frac{m_t}{P_t} = \frac{c_t}{2 \cdot 2}$

11

Cash balances over time for two transactions



12

So what are the tradeoffs to cash management?

- In general, average real money balances are

$$c_t/2\eta_t$$

- Keep cash balances low to minimize the opportunity cost of holding money

$$R\ c_t/2\eta_t$$

- Keep number of bank trips low to avoid the transaction costs

$$\gamma\eta_t$$

13

What is the optimal number of transactions per period ?

- Agent j must minimize the total cost of cash management,

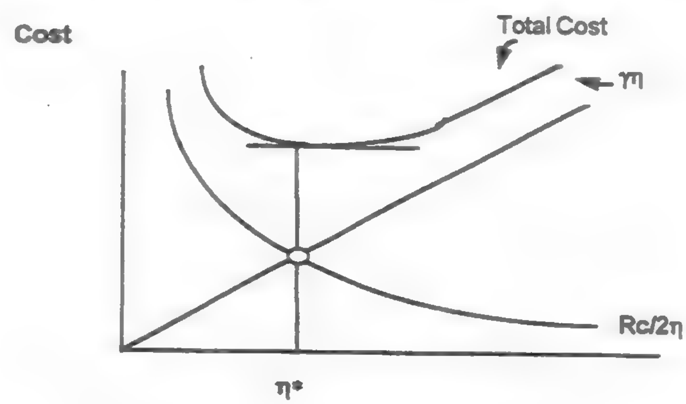
$$\min \quad \frac{R_t c_t^j}{2\,\eta_t^j} + \gamma\,\eta_t^j$$

- The solution to the minimization problem is

$$\eta_t^j = \sqrt{\frac{R_t c_t^j}{2\gamma}}$$

14

Optimum number of bank transactions



Optimal number of bank trips occurs at the minimum of total cost curve η*

15

What influences household j to go to the bank more often ?

$$\eta_t^j = \sqrt{\frac{R_t c_t^j}{2\gamma}}$$

- Increase in nominal interest rates, R_t
- Increase in real consumption, c_t^j
- Decrease in real transaction cost, γ

16

Since average money balances are inversely related to the number of bank trips, the same determinants apply

$$\frac{m_t^j}{P_t} = \frac{c_t^j}{2\,\eta_t} = L_t^j(\overset{-}{R_t}, \overset{+}{c_t^j}, \overset{+}{\gamma})$$

- Increase in nominal interest rates lowers money demand
- Increase in real consumption raises demand
- Increase in real transaction cost raises demand

17

Demand in the money market

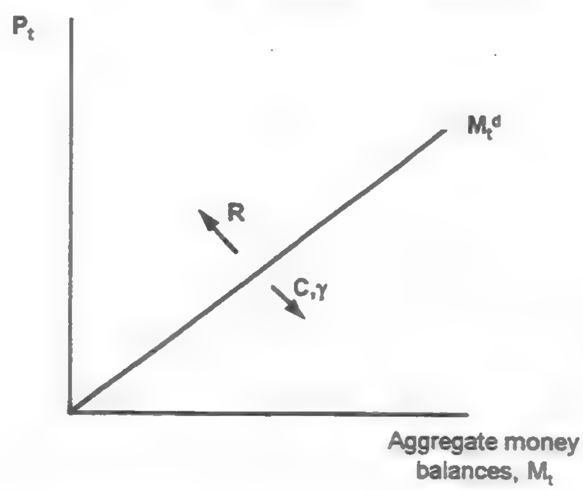
- To study the money market we aggregate the money demand of households,

$$M_t^d = P_t \cdot \sum_j L_t^j(R_t, c_t^j, \gamma)$$

- Movement along vs. shifts in demand curve.
  - aggregate demand for money is proportional to the price level (move along)
  - changes in R, C, γ shift money demand

18

The money market (Demand)



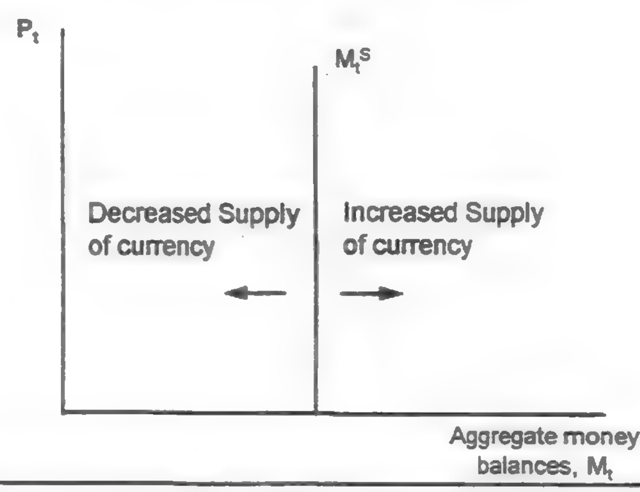
19

Supply in the money market

- For now, assume the money supply is fixed by the Fed, independent of the state of the economy (including P_t).
- This assumption implies the money supply curve is vertical (movement along).
- If the quantity supplied by the Fed changes, the supply curve shifts.

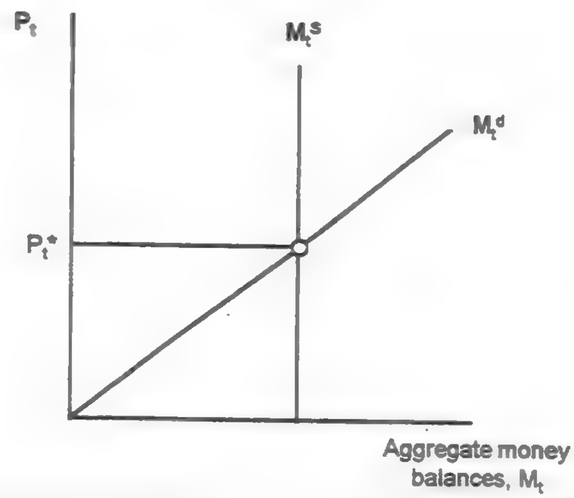
20

The money market (Supply)



21

Equilibrium in the money market

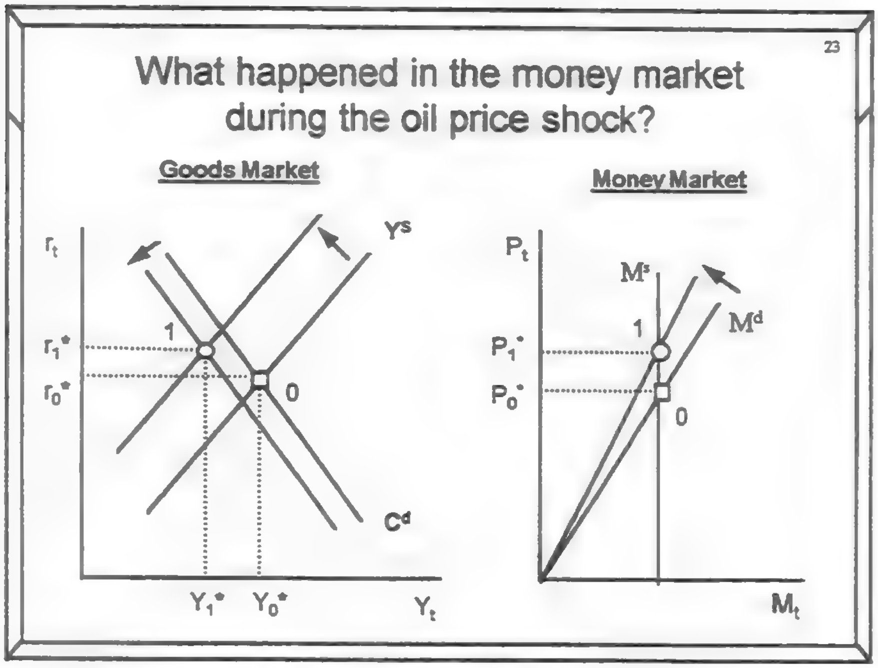


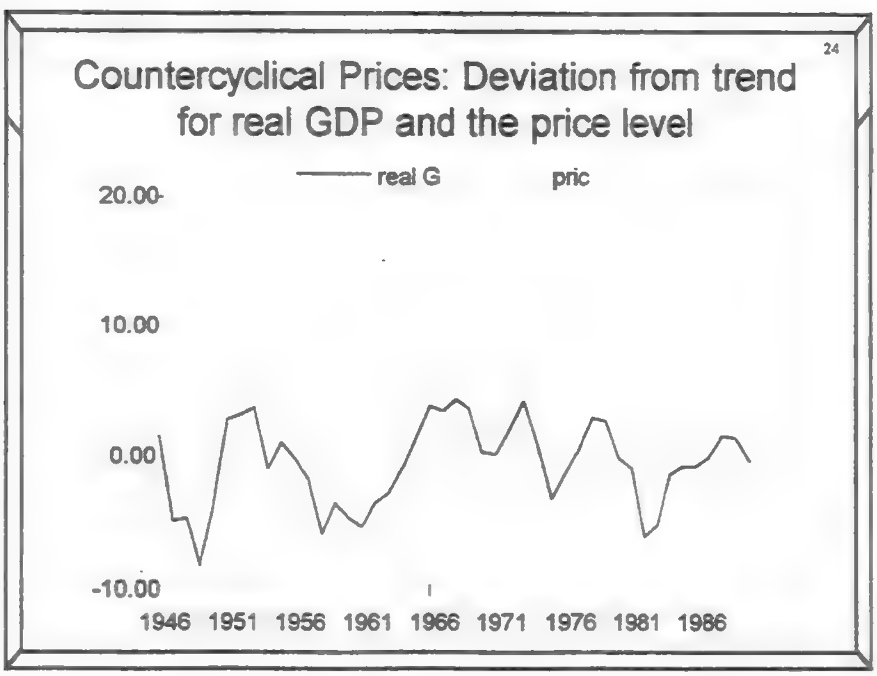
22

Oil price shocks and the aggregate price level

- Since oil is just one component of the consumption bundle, it's not clear the aggregate price level has to rise when oil prices rise.
- Recall however, we showed that

$$r_t \uparrow,\ C_t \downarrow$$
$$\Rightarrow M_t^d \downarrow$$
$$\Rightarrow P_t \uparrow$$


23
What happened in the money market during the oil price shock?
Goods Market
Money Market
r_t
r_1^*
r_0^*
1
0
Y^s
C^d
Y_1^*
Y_0^*
Y_t
P_t
M^s
M^d
P_1^*
P_0^*
1
0
M_t


24
Countercyclical Prices: Deviation from trend for real GDP and the price level
real G
pric
20.00
10.00
0.00
-10.00
1946
1951
1956
1961
1966
1971
1976
1981
1986

25

The Quantity Equation

- Re-writing the household's average money balances:

$$m_t^j \cdot 2\eta_t^j = P_t \cdot c_t^j$$

- Recall that the aggregate market clearing conditions are Md=Ms and C=Y. This motivates the Quantity Equation (QE):

$$M_t^s \; V_t \; = \; P_t \; Y_t$$

where V_t is the velocity of money, the number of times that a typical dollar circulates in t

- Notice that each side of the equation is a measure of the dollar volume of transactions

26

What does the Quantity Equation tell us ?

- Rewriting the QE in percent change form

$$\%\Delta M + \%\Delta V = \%\Delta P + \%\Delta Y$$

$$\text{or} \qquad \pi = \mu + \%\Delta V - \%\Delta Y$$

we find that inflation (π) is related to the growth rate of the money supply (μ) and factors which depend on real output growth

- As Milton Friedman put it, "Inflation is always and everywhere a monetary phenomenon."

27

Can we find this relationship in the data below ?

	Π	μ	$\Delta Y/Y$	$\Delta V/V$	Time
Brazil	77.8	77.4	5.6	6.0	'63-90
Argentina	76.0	72.8	2.1	5.3	'52-90
Israel	29.4	31.0	6.7	5.1	'50-90
U.K.	6.5	6.4	2.4	2.5	'51-90
France	6.2	7.0	4.1	3.3	'50-90
Japan	4.7	11.2	6.9	0.4	'53-90
U.S.	4.2	5.7	3.1	1.6	'50-90
W.G.	3.0	7.0	4.1	0.1	'53-90

28

Money growth and inflation
-source McCandless and Weber FRBMinn QR
Summer 95

1

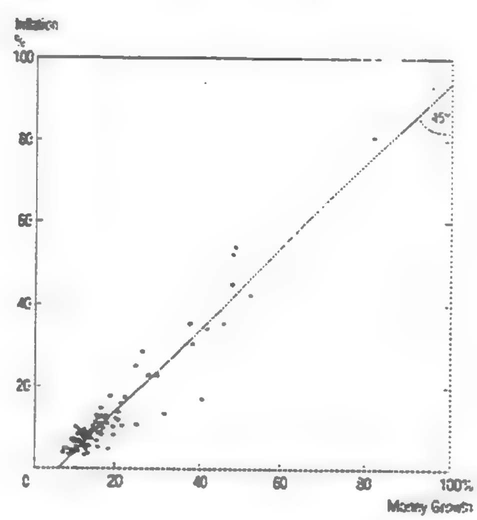
Correlation of money growth and inflation

Sample	Coefficient for Each Definition of Money M0	M1	M2
All 110 Countries	.925	.958	.950
Subsamples			
21 OECD Countries	.894	.940	.958
14 Latin American Countries	.973	.992	.993

*Inflation is defined as changes in a measure of consumer prices
Source of basic data: International Monetary Fund

2

Money growth and inflation



With inflation, we can relate real and nominal interest rates

- A lender will want to be compensated for the erosion in the value of the dollar, so

$$R = r + \pi$$

- Then we can specify real vs nominal returns:

	Money	Bonds
Nominal return	0	R_t
Real return	$-\pi_t$	r_t

30

Do monetary factors affect real interest rates in the long run?

- The real interest rate, r_t , is determined solely in the goods market by "real" factors such as preferences and technology
- Given r_t , the nominal interest rate, R_t , is determined by the money market through the relationship with π_t
- We call this delinking of the real and monetary sides of the economy the <u>classical dichotomy</u>

31

Where in our model can we see the existence of the classical dichotomy ?

- Looking at our IBC with money added

$$c_t + \frac{c_{t+1}}{1+r_t} = \theta_t f(n_t) + \frac{\theta_{t+1} f(n_{t+1})}{1+r_t} - \frac{m_t}{P_t}\left(1 - \frac{1}{1+r_t+\pi_t}\right) - \eta_t \gamma$$

we can see that the last two term are small in relation to the other terms, so the money market does not significantly impact the goods and bond markets.

32

money growth and output

3

Correlation of money and real GDP growth

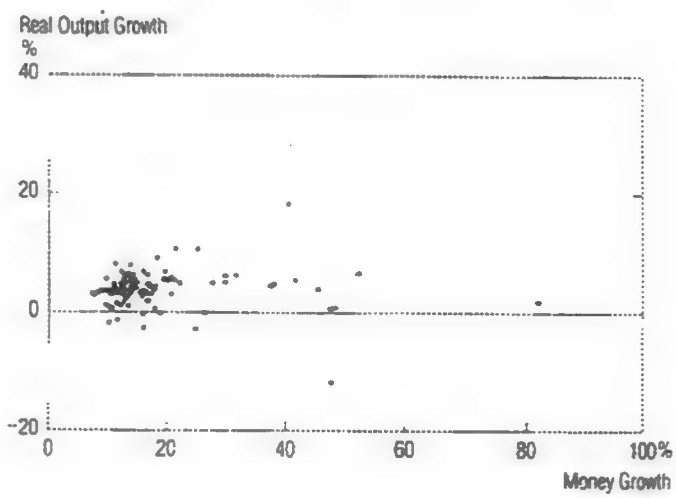
Sample	Coefficient for Each Definition of Money		
	M0	M1	M2
All 110 Countries	−.027	−.050	−.014
Subsamples			
21 OECD Countries	.707	.511	.518
14 Latin American Countries	−.171	−.239	−.243

*Real output growth is calculated by subtracting changes in a measure of consumer prices from changes in nominal gross domestic product

Source of basic data: International Monetary Fund

4

Money and real GDP growth



33

In next chapter

- We will examine the determinants of the money supply and the instruments of monetary policy used by the Fed

19

The Money Supply Process

What is the definition of money supply reported by the WSJ ?

- The Fed (Central Bank of the U.S.) focuses on M1, which is currency plus checkable deposits.

- The definition makes clear that the two principal actors in the money supply process are the Federal Reserve (currency) and commercial banks (checkable deposits).

How does the Federal Reserve control the money supply?

- The Fed sets <u>Reserve Requirements</u> for commercial banks (banks must hold 12% of checkable deposits in reserve to meet instant liquidity demand by households).
- The Fed is the "lender of last resort" at the <u>discount window</u>. A commercial bank deficient on reserves can borrow at the discount rate.
- The Fed buys and sells US government securities held by commercial banks through <u>Open Market Operations.</u>

To understand the money supply process we must understand how the Fed and commercial banks interact

- A simplified Fed balance sheet

Assets	Liabilities
Govt Securities (DC_F)	Currency (CUR)
Foreign Exchange Reserves (X)	Comm. Bank Reserves (CBR)

- A simplified commercial bank balance sheet

Assets	Liabilities
Govt Securities & Loans (DC_{CB})	Checkable Deposits (D)
Reserves (CBR)	

- The consolidated balance sheet

Assets	Liabilities
DC_F	CUR
DC_{CB}	D
X	
CBR	CBR
DC+X	CUR+D≡M1

- Another important measure is the monetary base, CUR + CBR, which is the main liability of the Fed

How does the Fed increase the money supply?

- The Fed buys T-bills from a commercial bank (an Open Market Purchase) for, e.g., $1 million and credits the comercial bank's reserves.

Fed

Assets	Liabilities
+1 DC_F	+1 CBR

Comm. Bank

Assets	Liabilities
-1 Govt Sec	
+1 CBR	

7

- Second, since CBR do not earn interest, the commercial bank makes loans to earn interest on these funds.

Comm. Bank

Assets	Liabilities
-1 Govt Sec	
+1 Loans	

8

- Next, the recipient of the loan spends the proceeds augmenting the seller's checkable deposits.
- The commercial bank must keep 12% of the funds as required reserves. It will make loans with the remaining 88% of the funds in order to earn interest.

Comm. Bank

Assets	Liabilities
-1 Govt Sec	
+1 Loans	
+.12 CBR	+1 D
+.88 Loans	

9

- The process of lending and depositing continues:

Comm. Bank

Assets	Liabilities
-1 Govt Sec +1 Loans	
+.12 CBR +.88 Loans	+1 D
+.11 CBR +.77 Loans	+.88 D

10

What ultimately happens to M1 ?
The Money Multiplier

- Since checkable deposits (D) are one component of M1, just add up the Ds

  1+.88+.77+...

- More formally, let ΔMB be the size of the original increase in CBR and let *re* be CBR/D, then $\Delta M = [1 + (1-re) + (1-re)2 + \ldots]\Delta MB$

  $= [1/re]\ \Delta MB$

- Thus, the ultimate change in M1 due to the $1 million increase in MB is 8.33 million.

A general derivation of the money multiplier

- Let *cu* be CUR/D and recalling that *re* is CBR/D, then

  (1) $M = CUR + D \equiv (cu+1)D$

  (2) $MB = CUR + CBR \equiv (cu+re)D$

  substituting (2) into (1) we get an expression for the money multiplier

  $$M = (1+cu)/(re+cu) \bullet MB$$
  $$\equiv mm \bullet MB$$

- In the data cu=.4 and re=.12, so M1 would expand by 2.69 million.

The Fed Funds market in commercial bank reserves

- At any time, individual banks may be above or below their required reserve positions.

- Commercial banks with deficient reserves can borrow on a short term basis (often overnight) from banks with excess reserves. The Fed Funds rate is determined on this basis.

- This interest rate will be influenced by the sole supplier of new reserves: the Fed.

13

- Modify the balance sheet to include Fed Supply of reserves (discount window borrowing and open market operations) as well as other commercial bank borrowing.

Fed Balance Sheet

Assets	Liabilities
DC_F	CUR
X	Non-borrowed CBR
Discount Window loans	

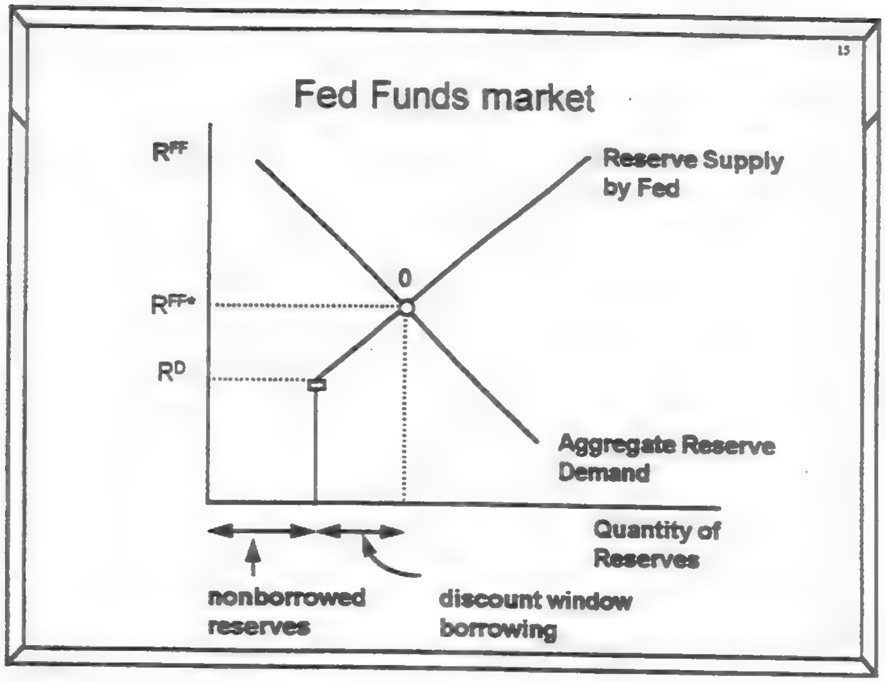
Comm. Banks Balance Sheet

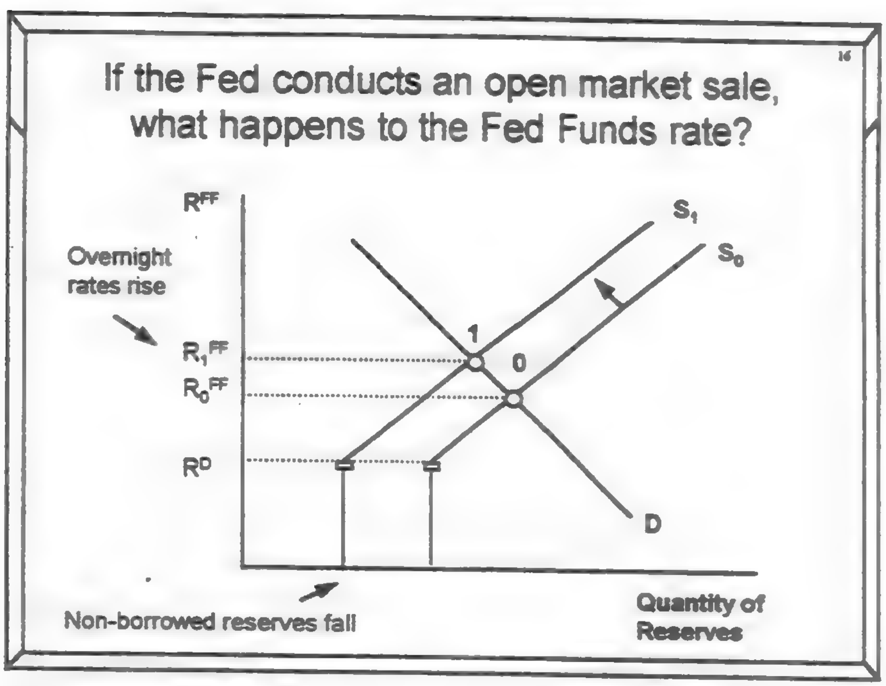
Assets	Liabilities
DC_{CB}	D
Non-borrowed CBR	Discount Window borrowing
Fed Funds loans	Fed Funds borrowing

14

Supply and demand in the Fed Funds market

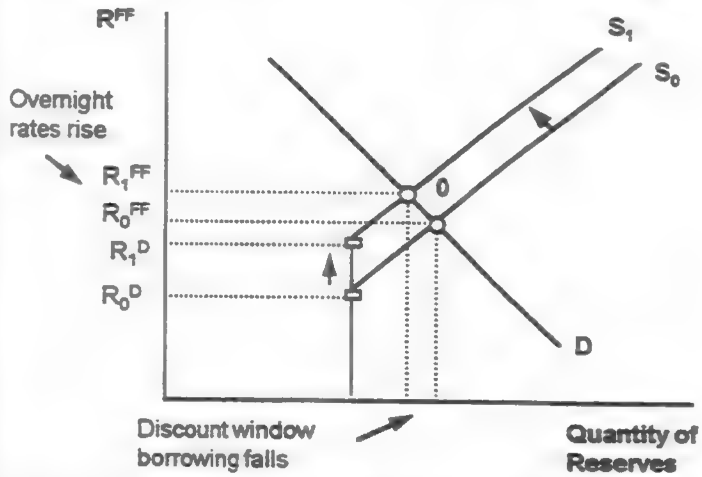
- Commercial bank demand for reserves arises from household demand for check deposits.
  - Since check deposits fall as interest rates rise, required reserves fall as well (i.e. downward sloping demand curve).
- The supply of reserves consist of non-borrowed reserves (via OMO) and discount window borrowing (at R^D). Since the Fed frowns on borrowing, supply slopes upward.


15
Fed Funds market
R^FF
Reserve Supply
by Fed
0
R^FF*
R^D
Aggregate Reserve
Demand
Quantity of
Reserves
nonborrowed
reserves
discount window
borrowing


16
If the Fed conducts an open market sale,
what happens to the Fed Funds rate?
R^FF
S1
S0
Overnight
rates rise
R1^FF
R0^FF
1
0
R^D
D
Non-borrowed reserves fall
Quantity of
Reserves

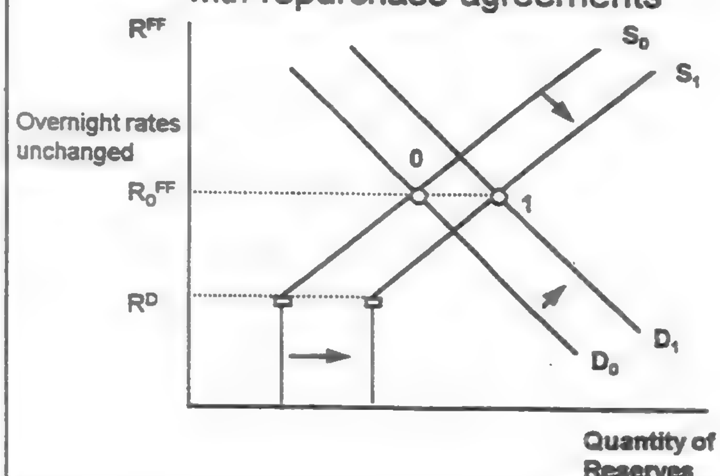
17

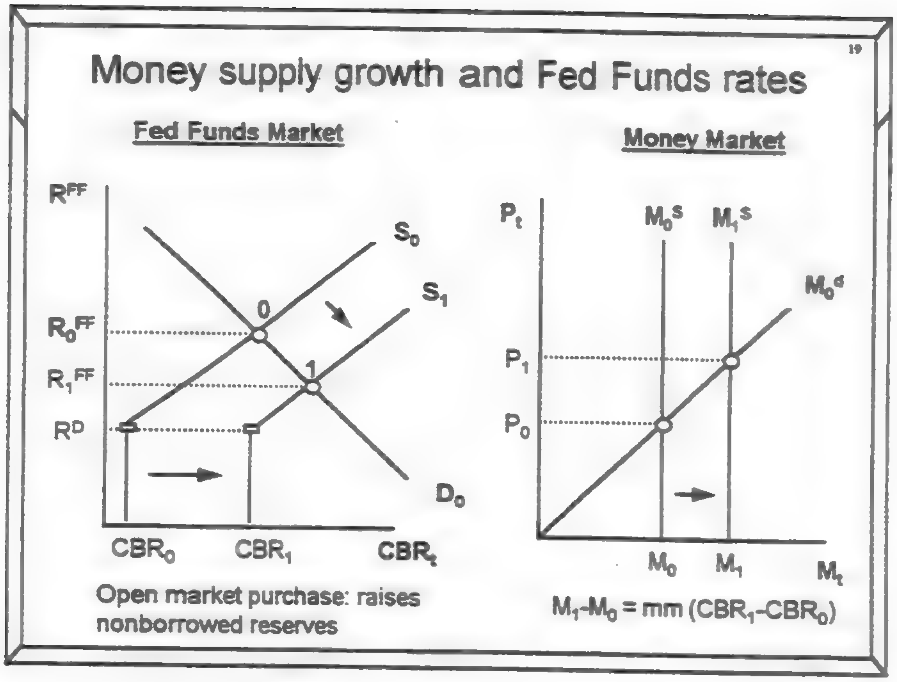
If the Fed raises the discount rate, what happens to the Fed Funds rate?



18

Pegging the Fed Funds rate during an increase in demand for checkable deposits with repurchase agreements




19
Money supply growth and Fed Funds rates
Fed Funds Market
Money Market
R^FF
S_0
S_1
0
1
R_0^FF
R_1^FF
R^D
D_0
CBR_0
CBR_1
CBR_t
Open market purchase: raises nonborrowed reserves
P_t
M_0^S
M_1^S
M_0^d
P_1
P_0
M_0
M_1
M_t
M_1-M_0 = mm (CBR_1-CBR_0)

IE

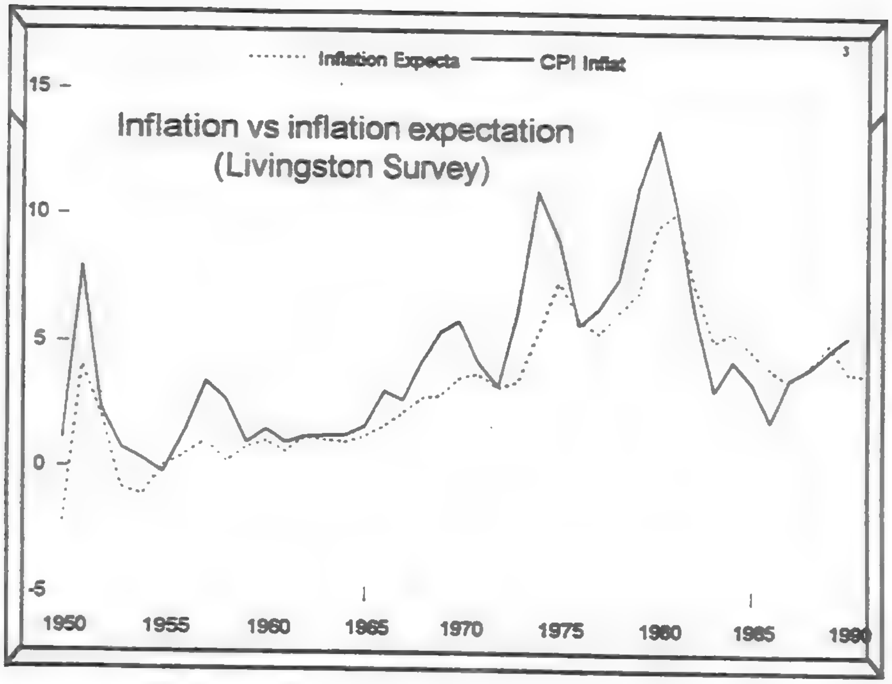
1

Asset Pricing under Uncertainty

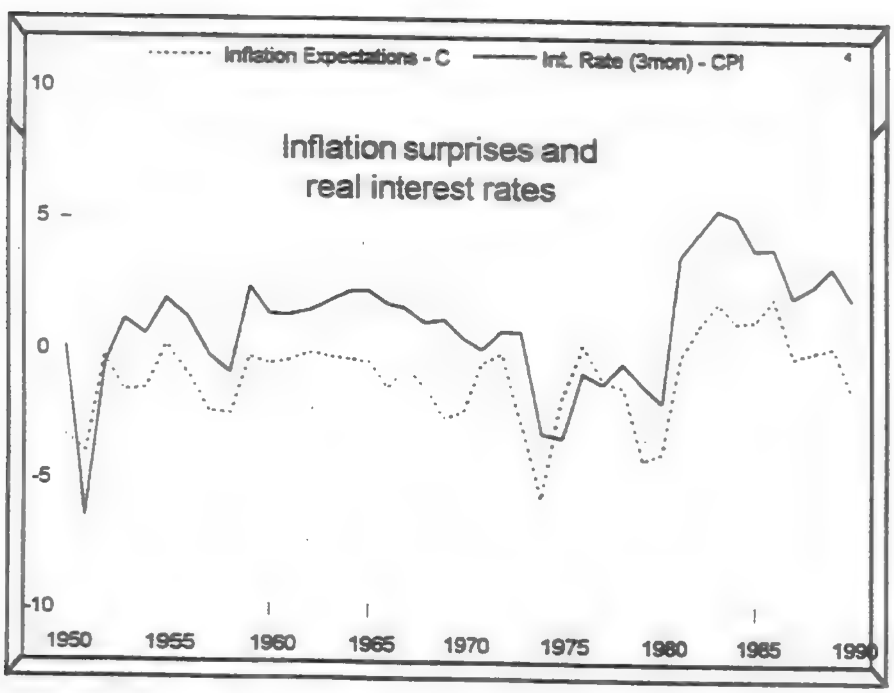
2

Besides helping us smooth consumption over time, assets help smooth consumption across uncertain states of the world

- For instance, since the future price level is uncertain when households make their borrowing/savings decisions, they demand or supply bonds on the basis of the expected real interest rate $r_t^e = R_t - \pi_t^e$, which incorporates expected inflation.
- When inflation expectations are incorrect, there is a real transfer between lenders and borrowers.



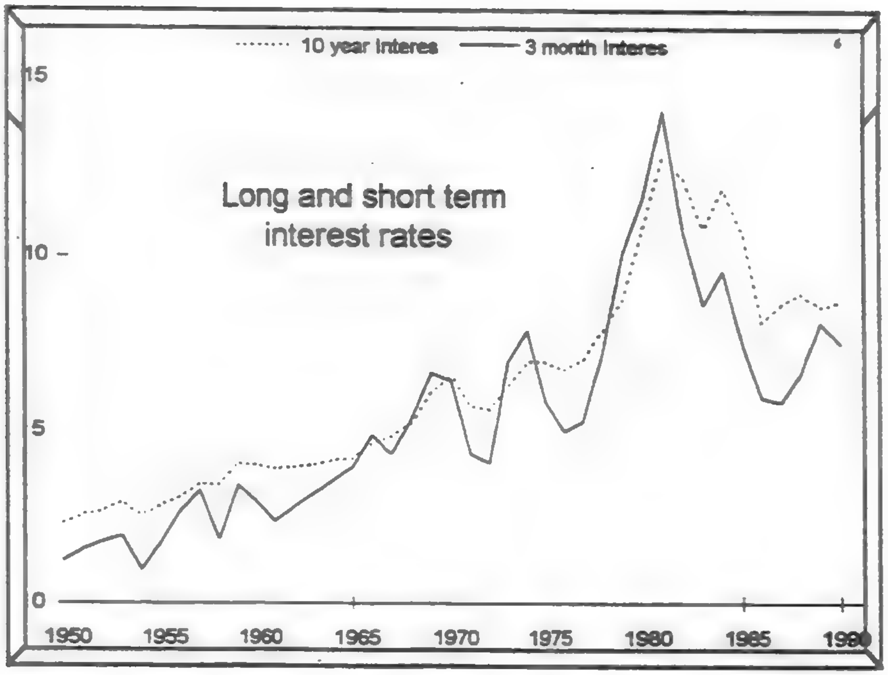
Inflation Expecta
CPI Inflat
Inflation vs inflation expectation
(Livingston Survey)
15
10
5
0
-5
1950
1955
1960
1965
1970
1975
1980
1985
1990



Inflation Expectations - C
Int. Rate (3mon) - CPI
Inflation surprises and
real interest rates
10
5
0
-5
-10
1950
1955
1960
1965
1970
1975
1980
1985
1990

How does uncertainty impact the yield curve?

- Recall, the definition of the yield curve is the plot of yields on bonds with differing terms to maturity but the same risk.
- In the next graph, we plot long term rates (10 yr govt. bonds) against short term rates (3 month govt. bills) over time.
- Notice, there are episodes where short rates lie above long rates.



7

Arbitrage and the pricing of short and long term bonds

- For simplicity, define a short term rate as lasting one period with return of $(1+R_t^S)$ each period and define a long term rate as lasting two periods with return of $(1+R_t^L)$ each period.
- There are two saving strategies,
  - buy a short term bond at t and roll it over into another short term bond at t+1:
    - expected return $(1+R_t^S)(1+R_{t+1}^{Se})$
  - buy one long term bond at t:
    - known return of $(1+R_t^L)^2$

8

- Assume the saver is risk neutral.
- Suppose $(1+R_t^L)^2 > (1+R_t^S)(1+R_{t+1}^{Se})$, then the saver would sell in the short market and buy in the long market. This would put upward pressure on prices in the long market (lowering long returns) and downward pressure in the short market (raising short returns).
- This arbitrage continues until the rhs=lhs

$$(1+R_t^L)^2 = (1+R_t^S)(1+R_{t+1}^{Se})$$

9

- Taking the logarithm of both sides and using the approx. log(1+x)≈x, the equality becomes

$$R_t^L = \frac{r_t^S + \pi_t + r_{t+1}^{Se} + \pi_{t+}^e}{2}$$

i.e. the long rate is average of two short rates.

- This is known as the expectations hypothesis of the term structure. It predicts that
  - $R_t^S > R_t^L$ when $\pi_t > \pi_{t+1}^e$, (i.e. the yield curve is downward sloping)
  - $R_t^S < R_t^L$ when $\pi_t < \pi_{t+1}^e$, (i.e. the yield curve is upward sloping)

10

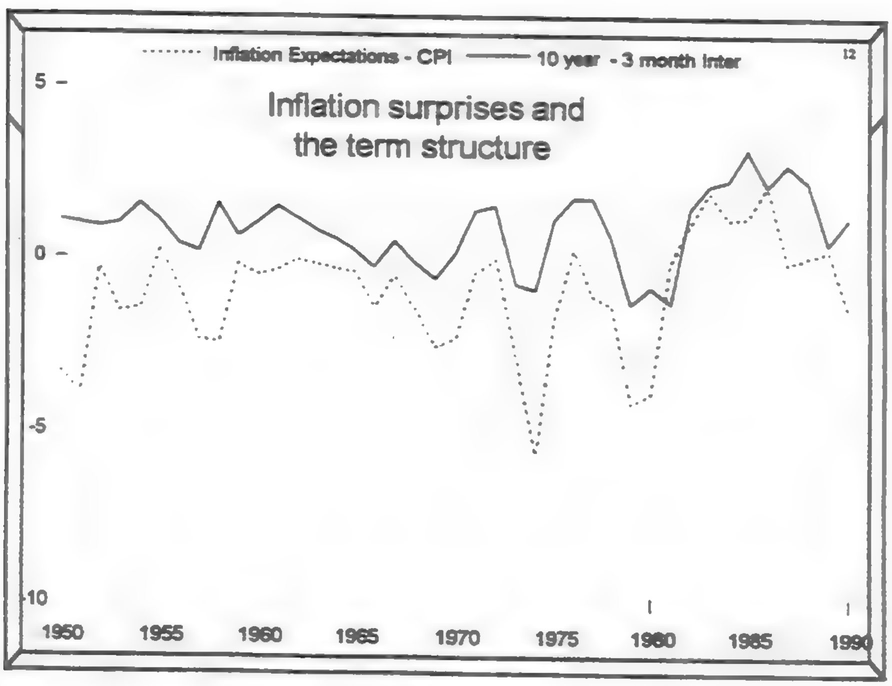
How does the Fed react to a steeply sloped yield curve?

- The Fed needs to lower expected inflation.
- The Fed conducts open market sales of T-bills, lowering commercial bank reserves and ultimately M1.
- With less money chasing goods, prices should be expected to fall (In the money market diagram, supply shifts left).
- The short term effect of the decrease in bank reserves is a rise in Fed Funds rates (In the Fed funds market diagram, supply shifts left).

As we've seen before, economists often get surprised by inflation.
What's the impact on the yield curve ?

11

- Since long rates are based on inflation expectations:
  - in a period of underprediction of inflation, long rates can fall below short rates (e.g. '74 and '79)
  - in a period of overprediction, long rates are substantially higher than short rates (e.g. '82).



13

On a General Method to Price Assets

- Apply the same concepts as before:
  - need to know household's preferences
  - add any new assets to the household's budget constraint.

14

Preferences

- To keep things simple, let household's intertemporal preferences be separable over consumption today and tomorrow:

$$U(c_t, c_{t+1}) \equiv U(c_t) + \frac{1}{1+\rho} E\left[U(c_{t+1}) \middle| \Im_t\right]$$

where $1/(1+\rho)$ is the agents discount factor and $E[\, x \mid \Im_t]$ is defined to be the expectation of variable x given information $\Im$ available at time t

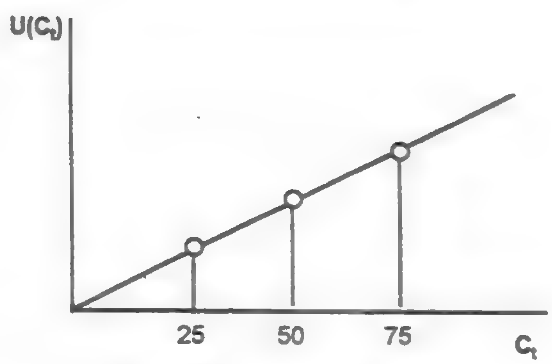
15

How do we address risk in the household's decision making ?

- A risk neutral saver is indifferent between a sure bet and a gamble that yields the same expected payoff.
- A risk averse saver prefers a sure bet to the above gamble.

16

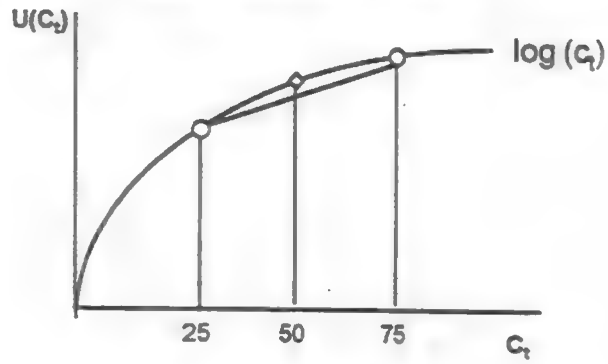
Risk neutral agents



- Receive 50 for sure utility = k 50
- Receive 25 or 75 with a coin flip = (1/2) k 25 + (1/2) k 75 = k 50

17

Risk averse agents



- Receive 50 for sure utility = 3.91
- Receive 25 or 75 with a coin flip = (1/2) 3.22 + (1/2) 4.32 = 3.77

18

Consumption and savings opportunities

- For simplicity, suppose the household holds only stocks (no bonds or money) in their portfolio. Then the budget contraint in real terms is

$$c_t + q_t^s s_t = y_t + (q_t^s + d_t) s_{t-1}$$

for each period where

q_t^S is real price of a share of stock

d_t is real dividend on a share of stock

s_t are the stock holdings.

Pricing Stocks

- The marginal cost of purchasing a share of stock (and forgoing consumption) in t is the marginal utility loss in real terms

$$q_t^S \, \Delta U(c_t)$$

- The marginal benefit of one share is the consumption the stock buys you in the future; i.e. the discounted marginal utility gain at t+1 based on real capital gains and dividends.

$$\frac{1}{1+\rho} E\left[\Delta U(c_{t+1})\,(q_{t+1}^s + d_{t+1})\,|\Im_t\right]$$

- Setting MC=MB we have

$$q_t^s = \frac{1}{1+\rho} E\left[\frac{\Delta U(c_{t+1})(q_{t+1}^s + d_{t+1})}{\Delta U(c_t)}\,|\Im_t\right]$$

where q_t^s is real price and d_t is real dividend.

21

Pricing stocks with risk neutral agents

- For the <u>risk neutral agent</u>, $\Delta U(c_{t+1})/\Delta U(c_t)=1$ and then

$$q_t^s = \frac{1}{1+\rho} E\left[q_{t+1}^s + d_{t+1} \middle| \Im_t\right]$$

- Iterating this expression forward one period and substituting for q^s_{t+1} gives:

$$q_t^s = \frac{1}{1+\rho} E\left[\frac{1}{1+\rho} E\left[q_{t+2}^s + d_{t+2} \middle| \Im_{t+1}\right] + d_{t+1} \middle| \Im_t\right]$$

22

- Continuing to substitute for future prices,

$$q_t^s = E\left[\left(\frac{1}{1+\rho}\right)^{\infty} q_{t+\infty}^s + \sum_{j=1}^{\infty}\left(\frac{1}{1+\rho}\right)^{j} d_{t+j} \middle| \Im_t\right]$$

- As long as the expectation of distant future prices are bounded (i.e. there are no asset price bubbles), the first term will disappear due to discounting and we're left with the standard result that the real stock price is the expected present discounted value of real future dividends.

23

Pricing stocks with risk averse agents

- For a risk averse agent (with log preferences)

$$\frac{\Delta U(C_{t+1})}{\Delta U(C_t)} = \frac{C_t}{C_{t+1}} = \frac{1}{1+g_t}$$

where g_t is growth rate of real consumption. (Note: with goods market clearing g_t is the growth rate of real GDP).

- Then the stock price is

$$q_t^s = \frac{1}{1+\rho} E\left[\frac{1}{1+g_t} \bullet \left(q_{t+1}^s + d_{t+1}\right) | \Im \right]$$

24

- Using the math fact that E(XZ)=E(X)E(Z)+C(X,Z), the determinants of stock prices decompose into, first, the previous affects of dividends and, second, the risk premium.

$$q_t^s = \frac{1}{1+\rho} \left\{ E\left[\frac{1}{1+g_t} | \Im\right] \bullet E\left[q_{t+1}^s + d_{t+1} | \Im\right] \right.$$

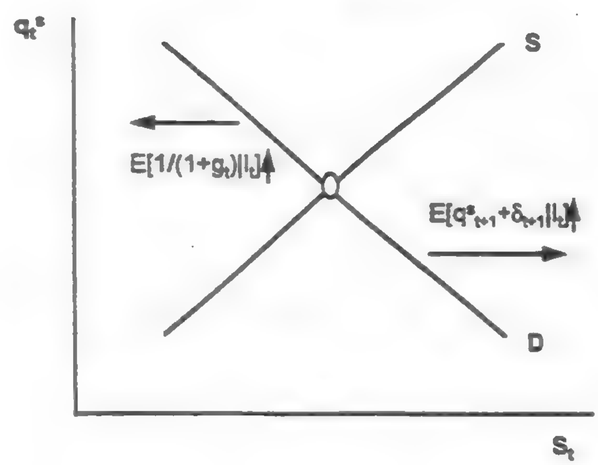
$$\left. + COV\left[\frac{1}{1+g_t}, \left(q_{t+1}^s + d_{t+1}\right) | \Im\right] \right\}$$

Risk Premium

Expectations and stock prices

- As expected future real prices of stocks or expected future real dividends increase, the demand for stocks rise and stock prices rise today.
- On the other hand, expectations of a future boom entice agents to consume more today, demand for stocks declines and stock prices fall today.

Stock market



27

The risk premium and stock prices

- Suppose the future sale price of the stock or future dividends are high just when the economy is perceived to go into a recession (i.e. $\downarrow g, \uparrow(q^s_{t+1} + d_{t+1})$). This results in cov>0.
- In this case, the stock is a great hedge against business cycle risk and its demand will be high.
- High demand results in a high price.

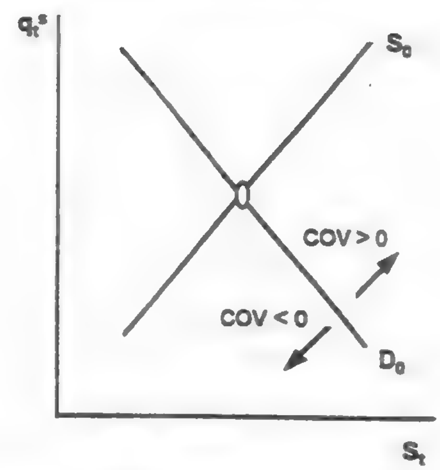
28

The risk premium and stock prices (cont.)

- Suppose the future sale price of the stock or future dividends are low just when the economy is perceived to go into a recession (i.e. $\downarrow g, \downarrow(q^s_{t+1} + d_{t+1})$). This results in cov<0.
- In this case, the stock is a terrible hedge against business cycle risk and its demand will be low.
- Low demand results in a low price.

29

Stock prices and risk



30

On the relation between CAPM and CCAPM

- In the standard capital asset pricing model (CAPM) the covariance of the return on a particular stock with the market portfolio determines its price.
- A stock that has a high return when the market has a high return (high cov, high β), doesn't provide a hedge against market downturns and its price must be low.
- A stock that has a high return when the market has a low return (low cov, low β stock), provides a good hedge against market downturns and its price must be high.

- The same intuition applies to the consumption capital asset pricing model (CCAPM) just presented where the covariance of stock market payouts with business cycle risk prices the market portfolio.
- Systematic risk associated with the business cycle affects all stocks. The procyclicality of earnings and dividends means the stock market doesn't provide much insurance against recessions and the "market" must compensate the saver with a high return.
- The higher return on stocks is known as the equity premium.

IF

1

The Labor Market

2

Introducing Firms

- We have modelled the determination of equilibrium labor hours by examining the preferences and production opportunities of households who act as entrepeneurs.
- Now we introduce a market in labor services:
  - firms demand labor
  - households supply labor
  - the market clearing price is the real wage.
- There is an equivalence between the two approaches.

3

Demand for Labor by Firms

- Firm j demands a quantity of labor hours (n^{dj}_t) to maximize profits

$$\text{Profits}^j_t = \text{Revenue}^j_t - \text{Cost}^j_t = P_t \bullet y^j_t - W_t \bullet n^{dj}_t$$

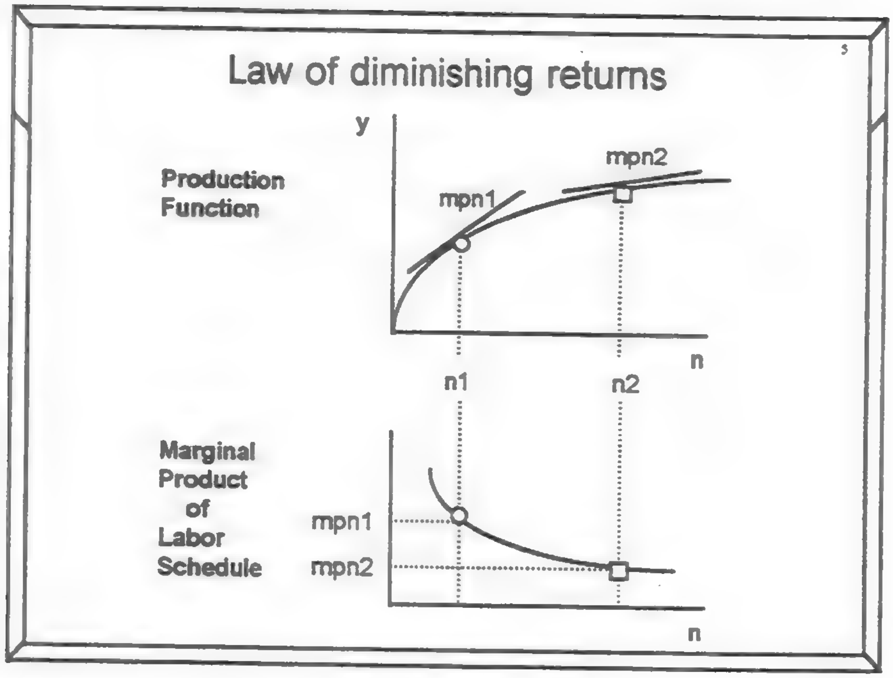
where P_t is the price level
y^j_t is the output of firm j
W_t is the nominal wage
n^{dj}_t is labor hours demanded by firm j

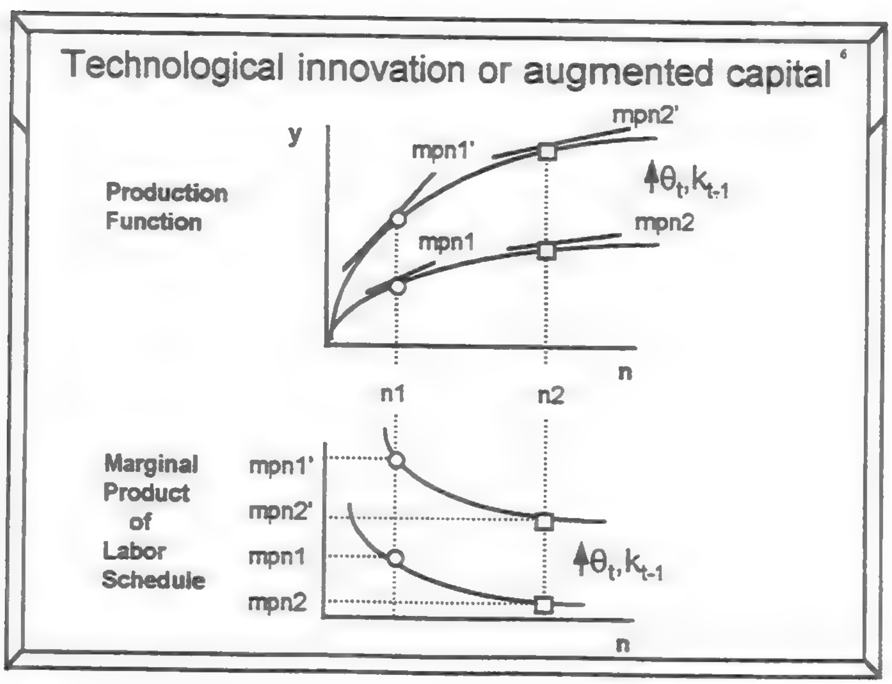
4

- The firm is the owner of the technology and has some existing capital.

$$y^j_t = \theta_t \, f(n^{dj}_t; k^j_{t-1})$$

- There are two assumptions about the productivity of labor (as before)
  - Law of Diminishing Returns
  - Capital and Technology are labor - augmenting


Law of diminishing returns
5
y
Production Function
mpn1
mpn2
n
n1
n2
Marginal Product of Labor Schedule
mpn1
mpn2
n


Technological innovation or augmented capital
6
y
mpn2'
mpn1'
Production Function
$\uparrow\theta_t, k_{t-1}$
mpn2
mpn1
n
n1
n2
Marginal Product of Labor Schedule
mpn1'
mpn2'
mpn1
mpn2
$\uparrow\theta_t, k_{t-1}$
n

7

Labor demand

- Assuming a competitive marketplace (P_t and W_t given), the firm demands labor by setting the marginal revenue product of labor (i.e. the marginal benefit) equal to the marginal cost of labor (per hour)

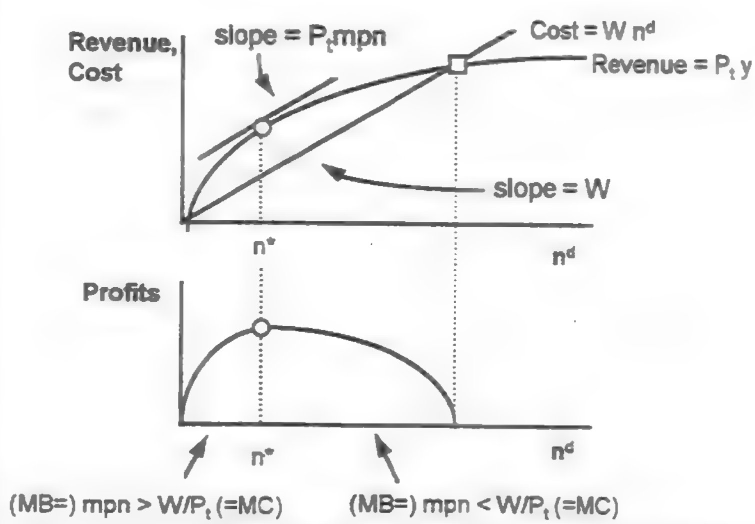
$$P_t \bullet mpn = W_t$$

or alternatively $mpn=W_t/P_t=w_t$, the real wage.

- This suggests that the demand for labor by firms is just given by their mpn schedule.

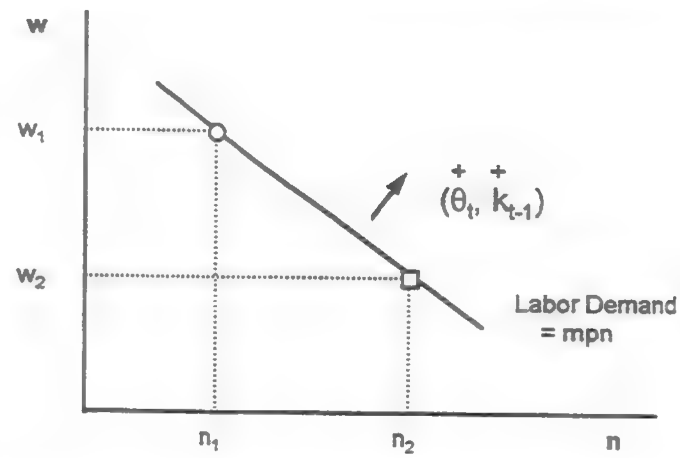
8

Choosing labor demand to maximize profits



9

Labor demand curve in real wage space



10

The Supply of Labor by Households

- Households determine how much labor to supply by maximizing utility subject to their budget constraint

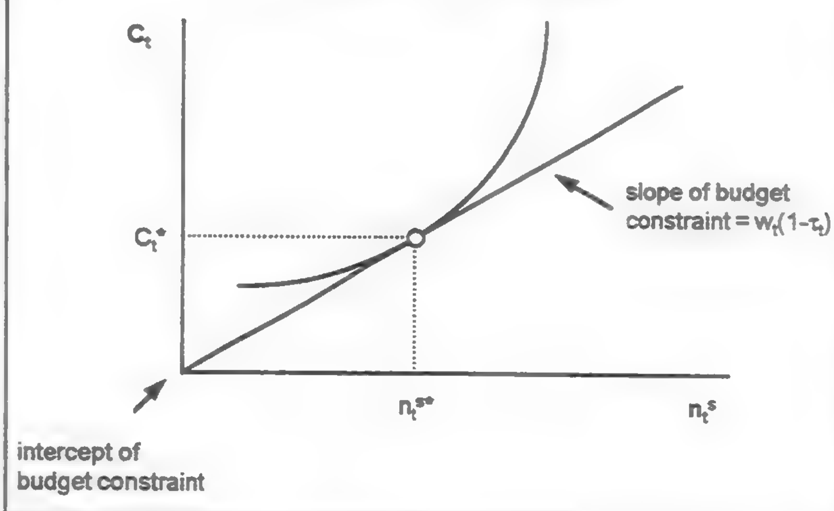
$$\text{Max } U(c_t^j, n_t^{sj})$$

$$\text{s.t. } c_t^j = \frac{W_t}{P_t}(1 - \tau_t) n_t^{sj}$$

where the budget says that consumption expediture equals wage income minus income taxes.

11

Household's problem

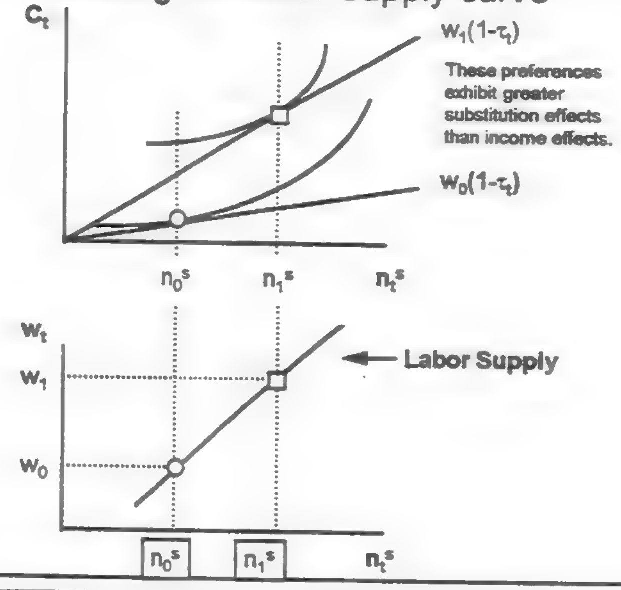


12

- At the optimum, the household sets the marginal benefit of working another hour (the real wage) equal to the marginal cost of working another hour (the disutility associated with work relative to leisure).
- Recall that from the firm's side, the real wage is equal to the mpn. This is why there was no loss in generality in the first half of the class where we simply considered entrepeneurs who set marginal benefit (mpn) equal to marginal cost (disutility).

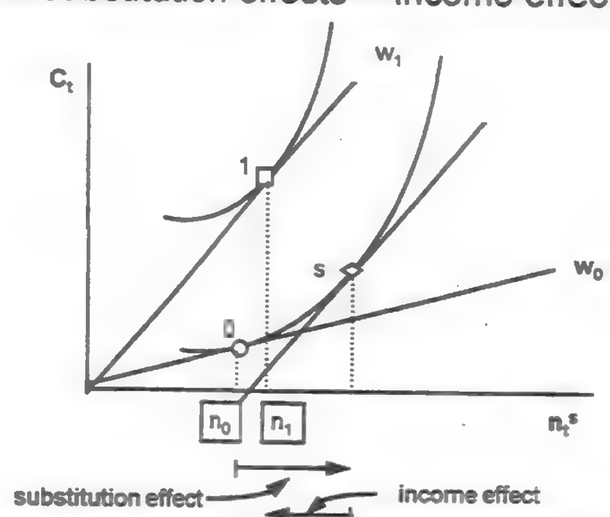
Deriving the labor supply curve

13



The upward sloping labor supply curve depends on substitution effects > income effects

14



15

Intertemporal effects on Labor supply

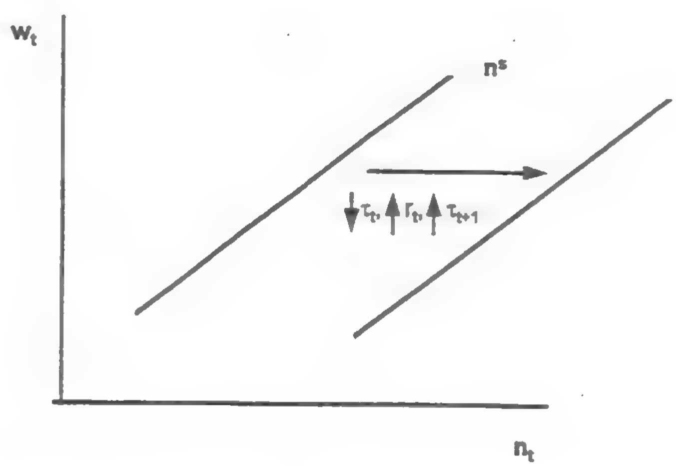
- The agent's intertemporal budget constraint

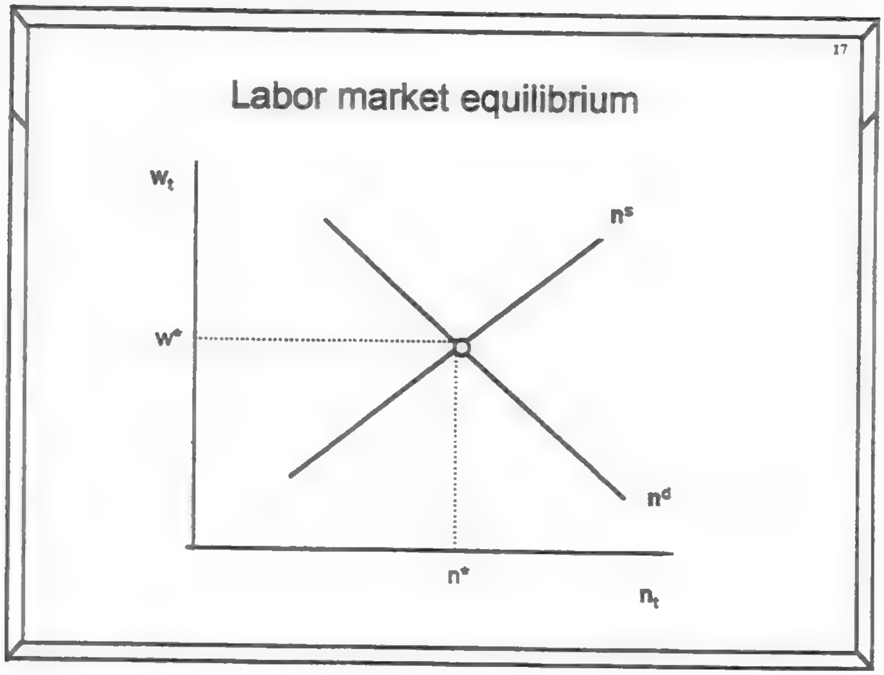
$$c_t^j + \frac{c_{t+1}^j}{1+r_t} = w_t(1-\tau_t)n_t^{sj} + \frac{w_{t+1}(1-\tau_{t+1})}{1+r_t}\, n_{t+1}^{sj}$$

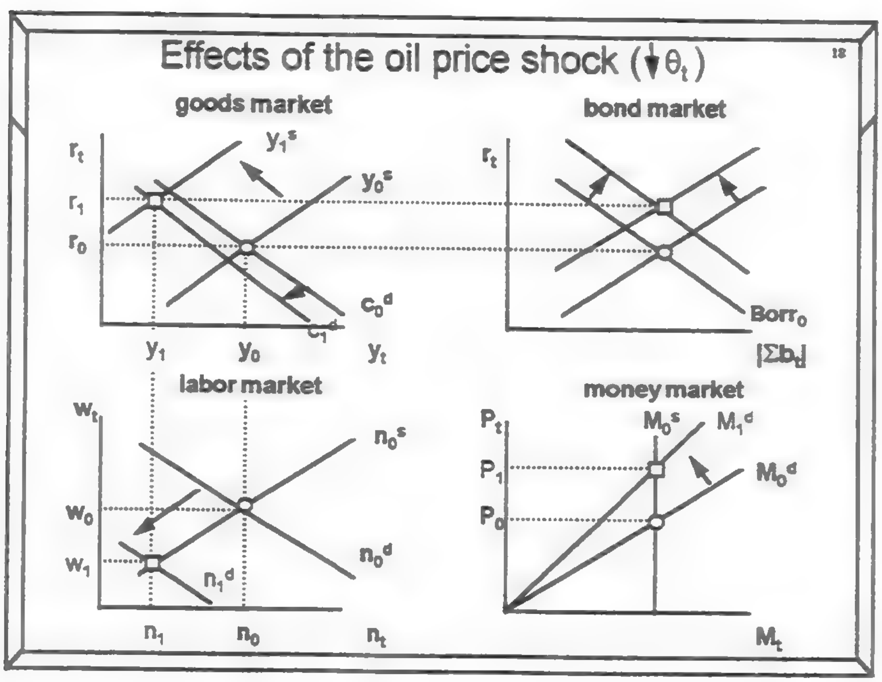
determines the changes in labor supply for changes in r_t, τ_t, and τ_{t+1}.

16

Shifts in the labor supply curve




17
Labor market equilibrium
w_t
n^s
w^*
n^d
n^*
n_t


18
Effects of the oil price shock ($\downarrow\theta_t$)
goods market
r_t
y_1^s
y_0^s
r_1
r_0
c_0^d
c_1^d
y_1
y_0
y_t
bond market
r_t
$Borr_0$
$|\Sigma b_t|$
labor market
w_t
n_0^s
w_0
w_1
n_1^d
n_0^d
n_1
n_0
n_t
money market
P_t
M_0^s
M_1^d
P_1
M_0^d
P_0
M_t

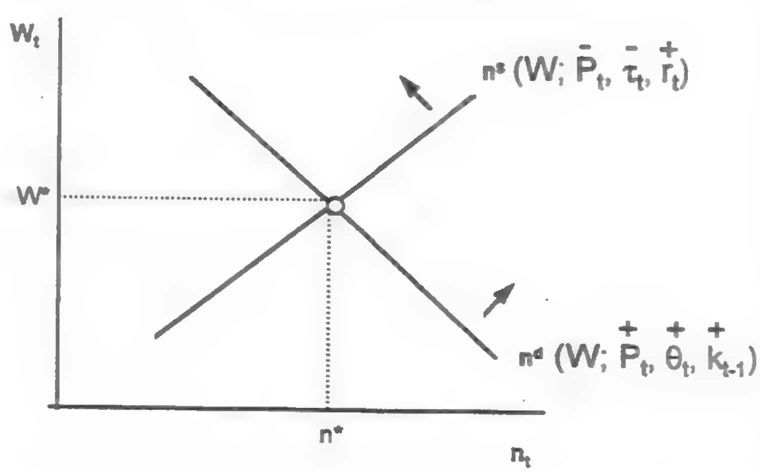
19

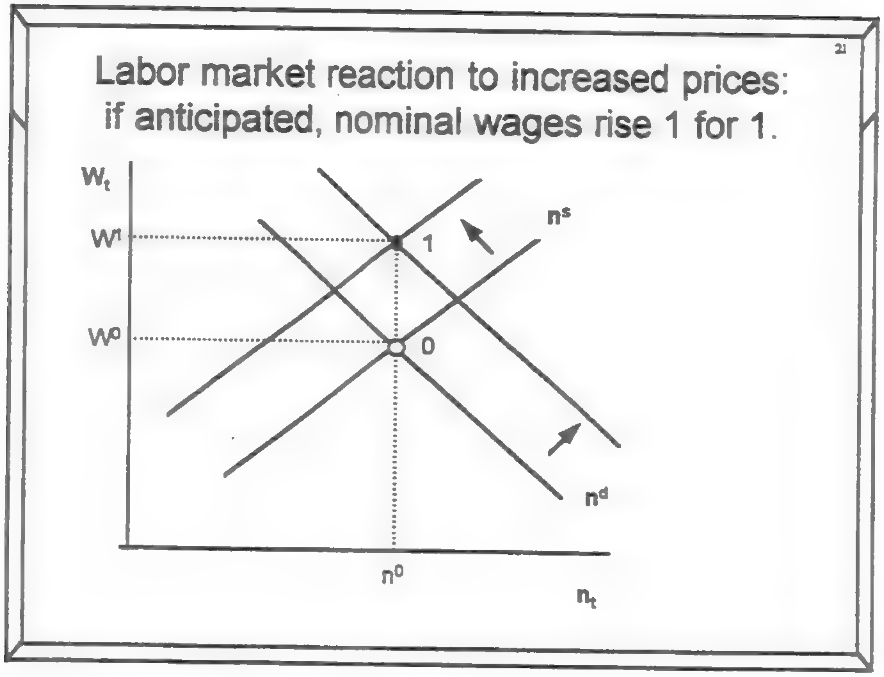
The labor market in nominal wage space

- Note that the real wage (w) is on the vertical axis in the labor market diagram.
- This means that changes in W or P_t are movements along the curve, rather than a shift of the curve.
- We could have graphed the labor market diagram in nominal wage space. In this case a change in P shifts the curve.

20

Labor market equilibrium in nominal wage space




21
Labor market reaction to increased prices: if anticipated, nominal wages rise 1 for 1.
W_t
W^1
W^0
1
0
n^s
n^d
n^0
n_t

16

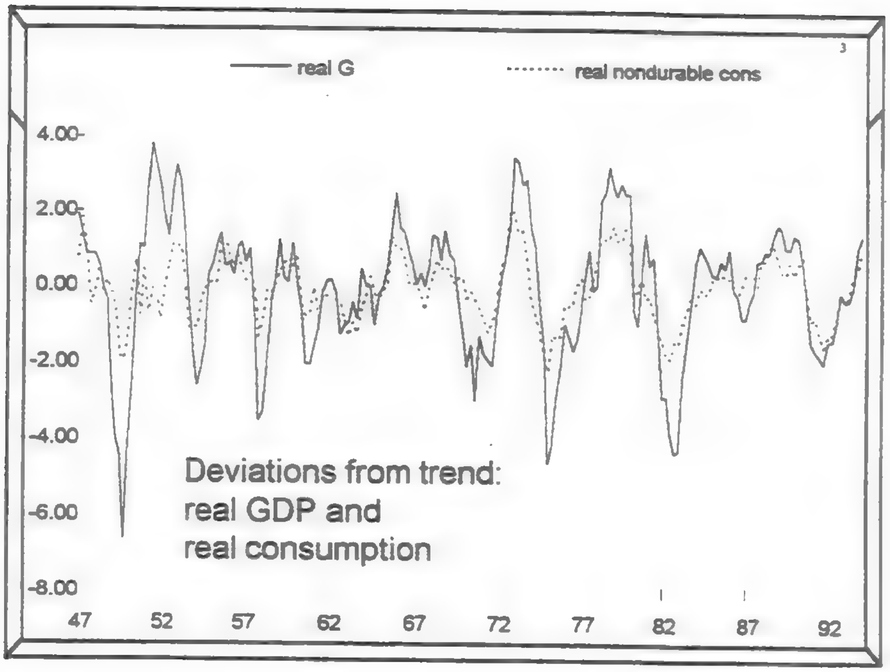
The Capital Goods Market

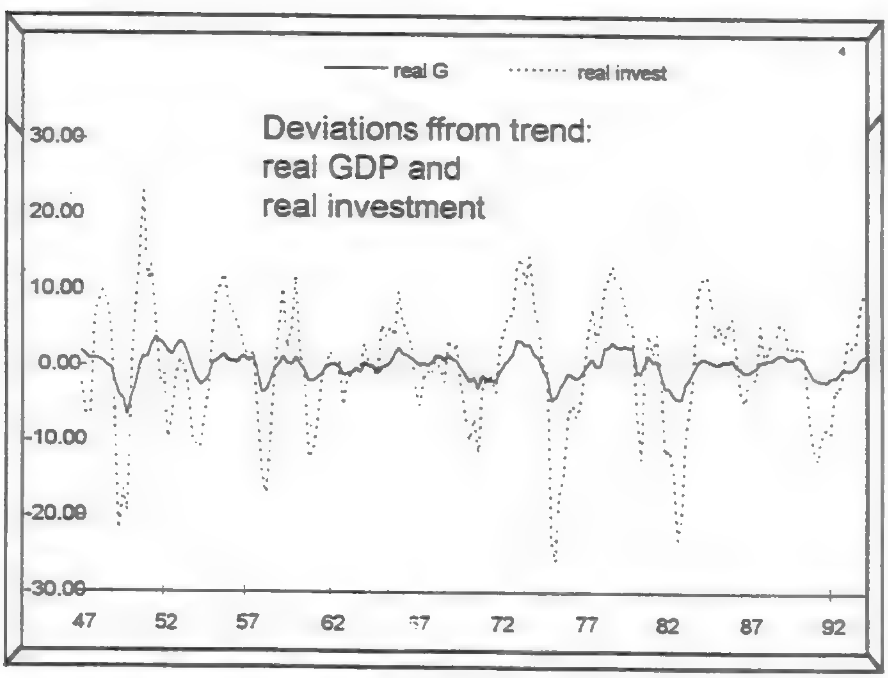
1

Investment: The Purchase of Durable goods

2

- Thus far we have studied production and consumption of only non-durable goods and services.
- Now we introduce investment in durable goods (goods that depreciate yet have a long lifetime).
- While non-durable goods consumption was smooth, we find that investment is extremely volatile across the business cycle.


real G
real nondurable cons
3
4.00
2.00
0.00
-2.00
-4.00
-6.00
-8.00
Deviations from trend:
real GDP and
real consumption
47
52
57
62
67
72
77
82
87
92


real G
real invest
4
Deviations ffrom trend:
real GDP and
real investment
30.00
20.00
10.00
0.00
-10.00
-20.00
-30.00
47
52
57
62
72
77
82
87
92

5

Investment

- The capital stock is the firm's durable equipment and structures.
- Investment is the change in the capital stock.
- If we denote the aggregate capital stock as

$$K_t \left(= \sum_j k_t^j \right)$$

then gross investment is defined by

$$I_t = K_t - K_{t-1} + \delta K_{t-1}$$

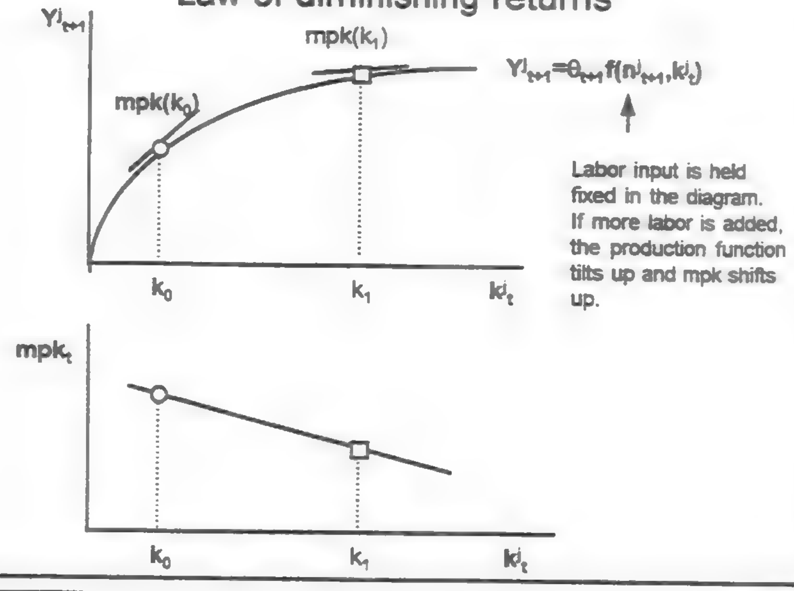
where δ is the depreciation rate.

6

Investment demand by firms

- As with the demand for labor, the firm chooses its capital to maximize profits.
- The firm's production function depends on the capital existing at the end of the previous time period (since it takes time to build or set up capital) $y_t^j = \theta_t f(n_t^j, k_{t-1}^j)$
- As with labor, the law of diminishing returns applies to capital in production.

Law of diminishing returns



- The firm's demand for capital is determined by setting the marginal revenue product of capital in period t+1 (when the capital comes on line) equal to the marginal cost of capital in t (when the capital is purchased).

9

- The marginal cost (MC) in t is P^K_t.
- The marginal benefit (MB) consists of the discounted expected marginal revenue from production in t+1 plus the revenue from selling the remaining capital (1-δ) in t+1

$$\frac{1}{1+R_t} E\left[P_{t+1}\ mpk_t + P^K_{t+1}(1-\delta)\middle|\Im_t\right]$$

where

$$mpk_t = \theta_{t+1}\frac{\Delta f(n_{t+1}, k_t)}{\Delta k_t}$$

10

- Equating MB & MC, dividing by P_t, we get

$$+\ R_t = (1+\pi^e_t)\ \{mpk^e_t \bullet \alpha + (1-\delta)$$

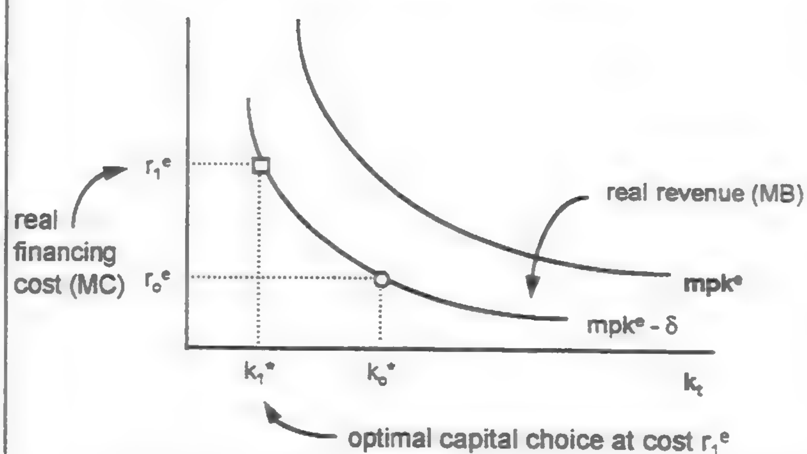
where α is the relative price of durables in terms of non-durables (i.e. $P_t=\alpha P^K_t$).
- Simplifying

$$MPK^e_t - \delta = r^e_t$$

which says the firm will purchase capital goods (invest) until its expected marginal real revenue net of depreciation equals the expected real financing cost.
- That is, the mpk determines capital demand.

11

The Demand for Capital



12

Capital demand, investment demand, and the demand for goods

- The determinants on capital demand are

$$k_t^j(\overset{-}{r_t^e}, \overset{-}{\delta}, \overset{+}{\theta}_{t+1}, \ldots)$$

- This implies that the effects on aggregate investment demand are

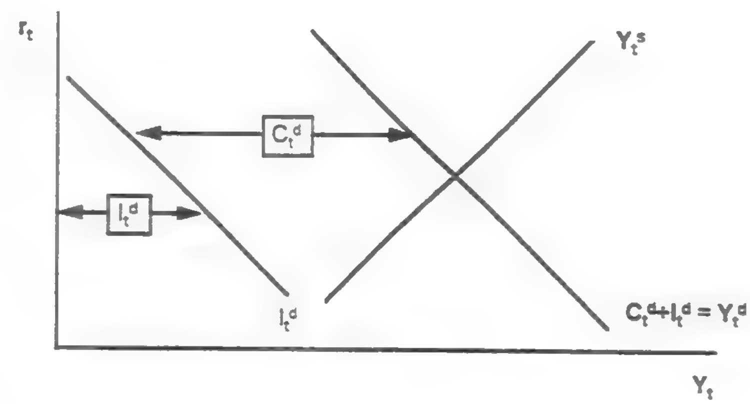
$$I_t^d(\overset{-}{r_t^e}, \overset{?}{\delta}, \overset{+}{\theta}_{t+1}, \ldots) = K_t(\overset{-}{r_t^e}, \overset{-}{\delta}, \overset{+}{\theta}_{t+1}, \ldots) - K_{t-1} + \delta K_{t-1}$$

- The goods market clearing condition now becomes

$$C_t^d + I_t^d = Y_t^s$$

13

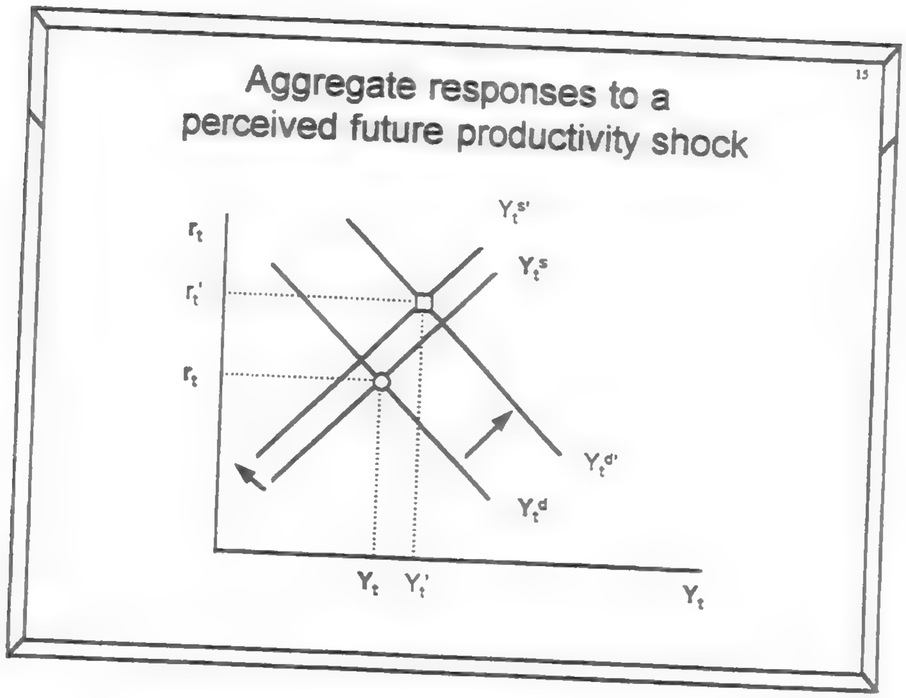
The goods market with investment



14

Effect of a perceived technology innovation ($\uparrow\theta(t+1)$) on the business cycle

- The perceived increase in mpk_t raises I^d_t.
- This induces workers to take more leisure in t and work harder in t+1, decreaseing Y^s_t.
- The perceived increase in income induces agents to consume more in t, increasing C^dt.
- For the business cycle, this results in
  - pro-cyclical real interest rates
  - pro-cyclical investment
  - pro-cyclical consumption
  - pro-cyclical labor hours


15
Aggregate responses to a
perceived future productivity shock
r_t
r_t'
r_t
$Y_t^{s'}$
Y_t^s
$Y_t^{d'}$
Y_t^d
Y_t
Y_t'
Y_t

1H

Fiscal Policy

Differences between Monetary and Fiscal Policy

- The classical dichotomy provided a strong implication for the effectiveness of monetary policy: monetary injections or withdrawals affect only nominal quantities like inflation and nominal interest rates.

- Fiscal policy, since it deals with purchasing real goods and taxing real income, can have effects on output and real interest rates.

3

- Fiscal policy deals with
  - the level of government expenditure
  - the method of financing expenditure
    - taxation
    - government borrowing
    - money creation (called seignorage)
- Where have we seen expenditure and receipts before? Just as households must act subject to a budget constraint, so too must the government (ha ha).

The Government Budget Constraint

4

- As in any budget constraint, the government's nominal expenditure equals nominal receipts

$$P_t \mathcal{G}_t + R_{t-1} B^g_{t-1} = P_t T_t + M_t - M_{t-1} + B^g_t - B^g_{t-1}$$

where

- $\mathcal{G}_t$ is total government real expenditure flow consisting of purchases of goods and services (G_t) and of transfer payments (such as social security, unemployment insurance,...)
- T_t is total government real taxation flow (such as income taxes, corporate profits tax, excise taxes and customs duties, social security levies, ...)
- $M_t > 0$, the nominal stock of government money
- $B^g_t > 0$, the nominal stock of government bonds

5

- Rewriting the constraint

$$B^g_t - B^g_{t-1} = P_t G_t + R_{t-1} B^g_{t-1} - P_t T_t - (M_t - M_{t-1})$$

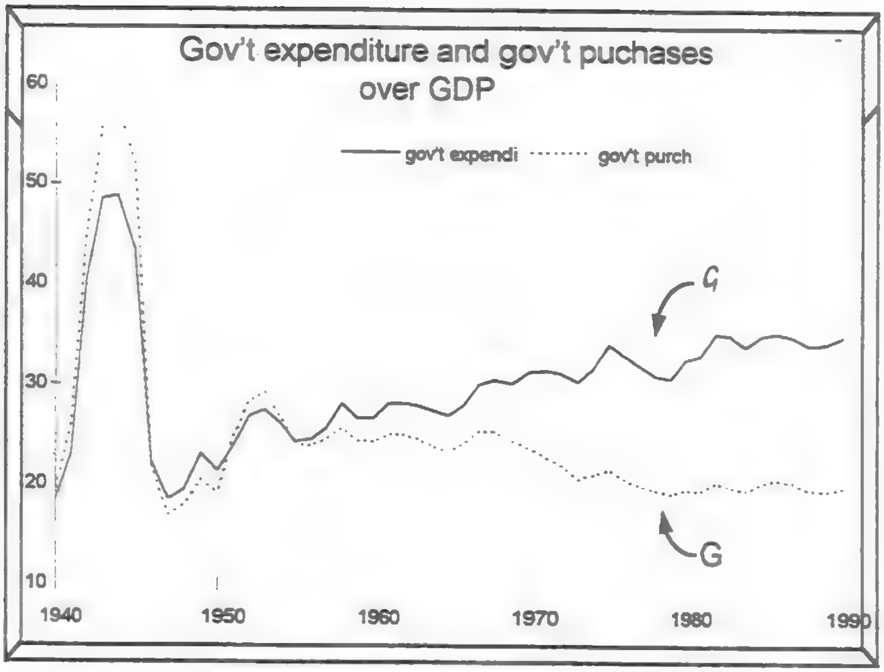
which says that changes in nominal government debt arise from the difference between nominal government expenditure and nominal revenue.

- Thus, increases in debt result from a government deficit (over-expenditure).
- Decreases in debt must result from government surpluses (under-expenditure).

6

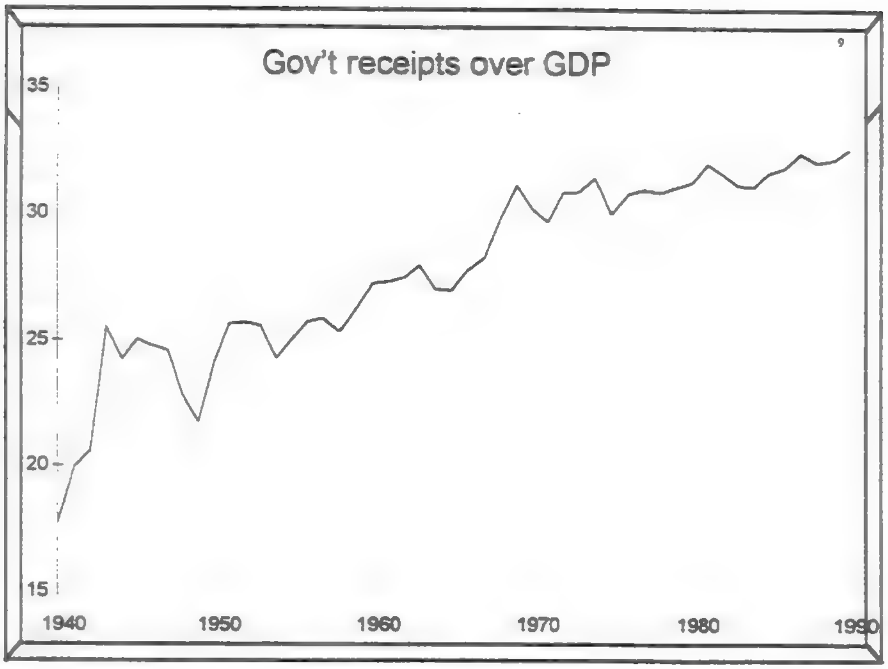
US government expenditure

- Since the 1950s there has been a steady rise in total government expenditure as a fraction of GDP. The changes in each of the components of government expenditure are
  - purchases G_t, declined
  - transfers, increased
  - interest payments, increased



US government receipts

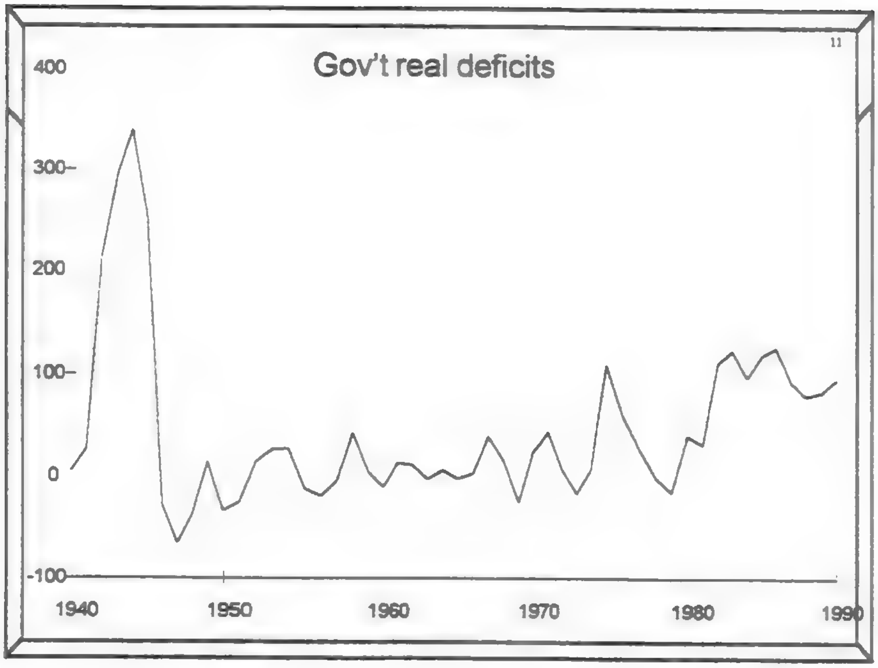
- Since the 1950s there has been a steady rise in government receipts, $T_t+(M_t-M_{t-1})/P_t$, as a fraction of GDP. The changes in each of the components of government receipts and their share of the total receipts are
  - income tax, relatively unchanged at 42%
  - corporate profits tax, declined to 7%
  - social taxes, increased steadily to 42%
  - excise and customs taxes, declined to 7%
  - revenue from money creation, only 2%

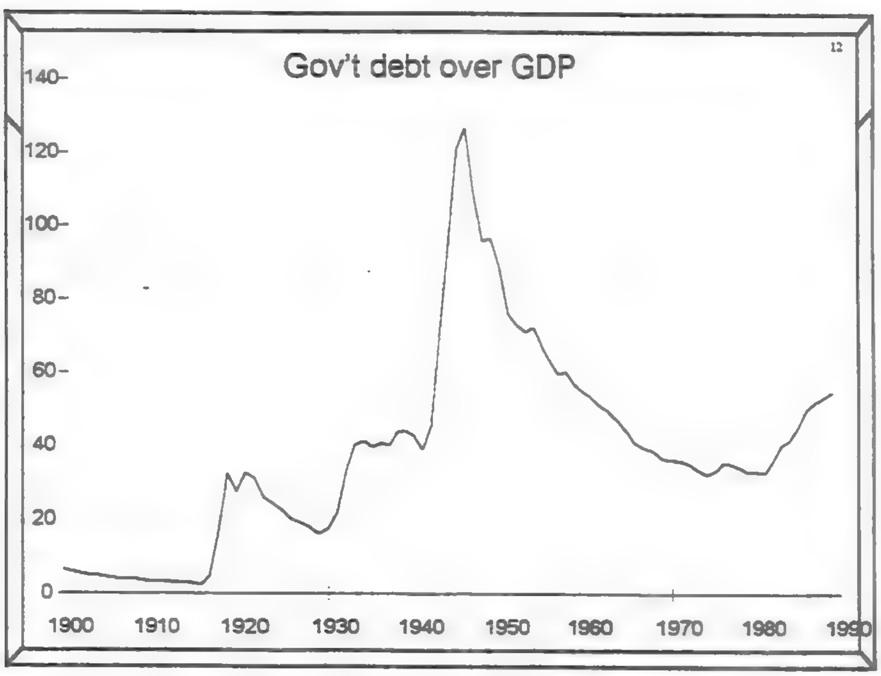


10

Debt and Deficits

- As stated previously, the stock of government debt arises out of the flows of government deficits.
- Since governments have excessive expenditure during wartime, deficits and the debt soar.
- After 1980 there has been an increased trend in US real government deficits and US debt as a fraction of GDP.


11
Gov't real deficits
400
300
200
100
0
-100
1940
1950
1960
1970
1980
1990


12
Gov't debt over GDP
140
120
100
80
60
40
20
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990

13

Does it matter when taxes are levied?
On the Timing of Taxes

- To answer this question, we need the intertemporal government budget constraint which comes from the sequence of static constraints (in real terms)

$$G_t - T_t = b_t^g - (1+r_{t-1})b_{t-1}^g + m_t - \frac{m_{t-1}}{1+\pi_{t-1}}$$

and

$$G_{t+1} - T_{t+1} = b_{t+1}^g - (1+r_t)b_t^g + m_{t+1} - \frac{m_t}{1+\pi_t}$$

where $b^g_t = B^g_t/P_t$ and $m_t = M_t/P_t$.

14

- For simplicity, assume that there is no initial debt or money and no money growth (since seignorage in the U.S. is so small).
- Substituting for b^g_t yields:

$$G_t + \frac{G_{t+1}}{1+r_t} = T_t + \frac{T_{t+1}}{1+r_t} + \frac{b_{t+1}^g}{1+r_t}$$

which says that PDV of expenditure must equal the PDV of tax revenue and PDV of future obligations.

15

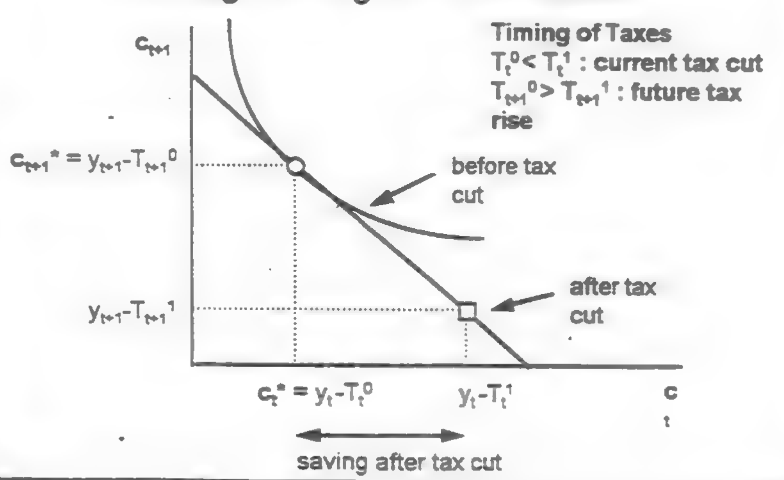
- Extending this for many periods, the future obligations would go to zero (provided there is not infinite government debt). Then the government IBC can be written as

$$\sum_{j=0}^{\infty}\left(\frac{1}{1+r}\right)^{j} G_{t+j} = \sum_{j=0}^{\infty}\left(\frac{1}{1+r}\right)^{j} T_{t+j}$$

- What does this say about the timing of taxes? If the government decreases taxes now without changing expenditure, then you should expect the government to raise taxes in the future.

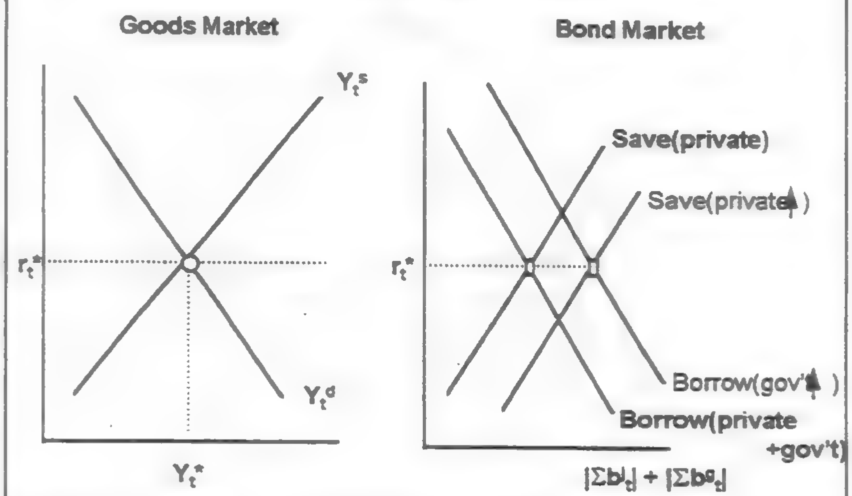
16

If government cuts current (lump sum) taxes, what will households do?
Recognize higher future taxes



17

Goods and money markets for a change in the timing of taxes



18

Ricardian Equivalence Theory

- The result that the timing of (lump sum) taxes may not affect real consumption or interest rates was suggested by David Ricardo (1772-1823).
- The equivalence of government issue of debt and taxes is known as the Ricardian Equivalence Theorem.

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Problems with Ricardian Equivalence Theory

- Since individual agents do not live forever and the lifetime of the government is much longer than the individual, if the government cuts taxes now and raises them after the agent is dead then the PDV of the household's income increases and the tax cut will affect spending and the economy.
- But if parents love their children, then they will save as before and there will be no effect on the economy.

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- An example: When the agent lives two periods and the government lives three periods, a \$100 tax cut at t implies either
  - a \$100(1+R) tax increase at t+1: in this case the PDV of the agents tax burden is -\$100 + \$100(1+R)/(1+R) = 0
  - a \$100 $(1+R)^2$ tax increase at t+2: in this case the PDV of the agents tax burden is just -\$100 (i.e. the tax burden has fallen)
- Only when the tax burden is passed to the next generation (and this generation doesn't care about the next) does consumption change.

21

What Ricardian Equivalence is not saying

- Ricardian equivalence is not saying that the level of government expenditure has no real effects.

- To examine the effects of government expenditure and taxation, use the goods market clearing condition with G_t

$$C_t^d(\overset{-}{r_t};\overset{-}{T_t},\ldots) + I_t^d(\overset{-}{r_t};\ldots) + G_t = Y_t^s(\overset{+}{r_t};\overset{+}{T_t},\ldots$$

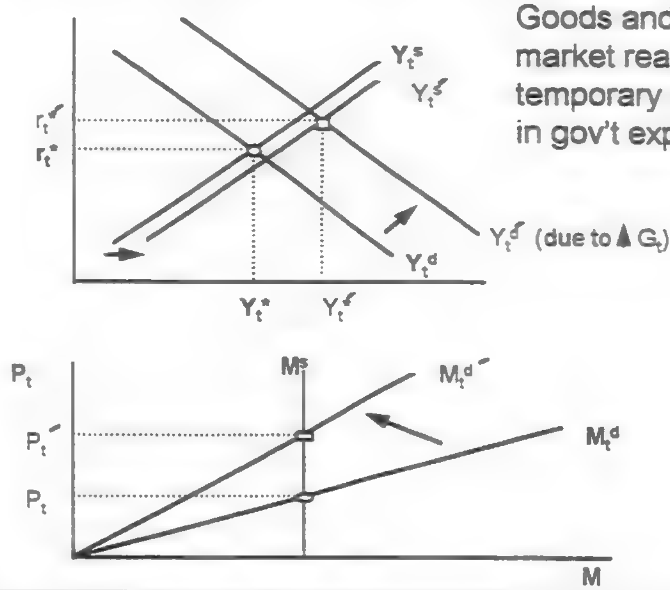
22

A temporary increase in government expenditure (with lump sum taxes)

- A temporary increase in G_t financed by an increase in T_t results in a decrease in $C^d{}_t$ and an increase in $Y^s{}_t$ (from the income effect of an increase in the lump sum tax - we'll assume this is small).

- In the goods and money markets this results in an increase in the interest rate and an increase in the price level.

23



Goods and money market reactions to temporary increase in gov't expenditure

24

Government's Crowding Out of Private Expenditure

- The increase in interest rates results in a decrease in investment (movement along the Y^d curve).
- The temporary increase in government expenditure results in <u>crowding out of private expenditure</u> since C_t and I_t decrease.

25

A permanent increase in government expenditure

- With a permanent increase, the PDV of the tax burden is even greater, resulting in more significant decreases in consumption and leisure (the resulting decrease in private consumption goods is more than offset by government spending).
- As before consumption (C_t) decreases, but investment (I_t) is unchanged since the interest rate is unchanged. Firms just invest in capital for producing government goods.

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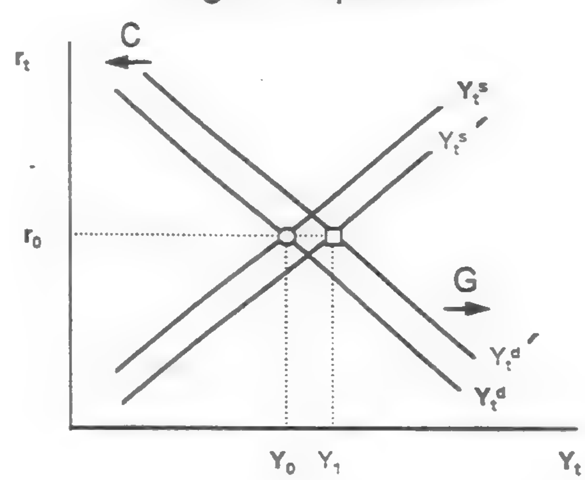
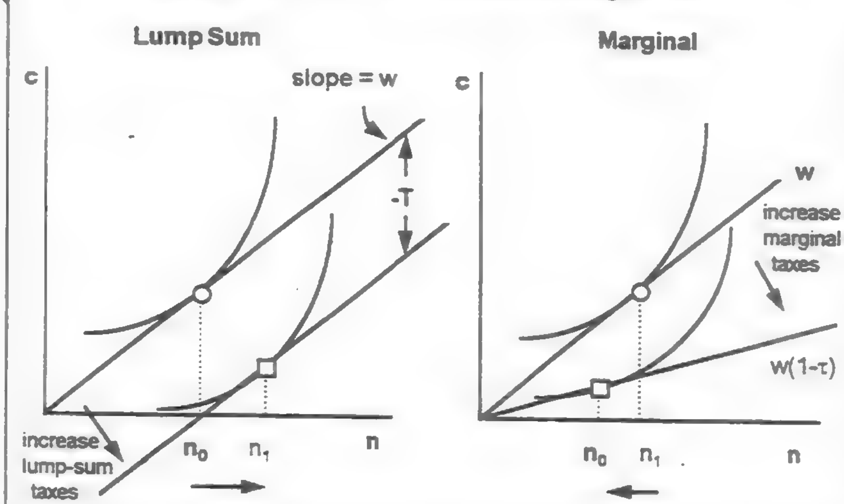
Goods market reaction to an increase in gov't expenditure



Distortionary taxes

- Lump sum taxes did not distort the "margins" of economic behavior. However, most taxes (such as income taxes, capital gains taxes, and sales taxes) have distortionary effects.
- For example, distortionary wage taxes:
  - With lump sum taxes , labor effort rises with an increase in taxes (income effects)
  - with (marginal) income taxes, labor effort falls with an increase in taxes (substitution effects dominate income effects).

Labor supply decision for lump sum and (marginal) wage taxes



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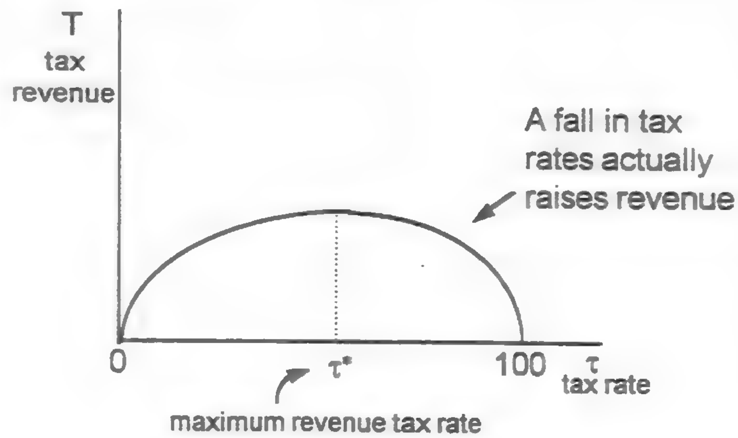
The Laffer curve: Distortionary Effects of Labor Income Taxes



30

- Real tax revenues from labor income are $T=\tau^*Y_t$. Changes in revenues can be decomposed into $\Delta T=Y_t^*\Delta\tau+\tau^*\Delta Y_t$, where Δ stands for change.

- Thus, while a decrease in marginal tax rates directly decreases tax revenues ($Yt^*\Delta\tau$ falls), it can indirectly increase revenues through increased work effort ($\tau^*\Delta Yt$).

- Which effect wins out depends on the strength of substitution effects.

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- Distortionary taxes for firms: The effects of the marginal corporate profits tax (τ^{CP}), capital gains taxes (τ^{CG}), and investment tax credits (itc) on investment decisions of the firm are revealed in the equality of marginal benefit and marginal cost:

$$P_t^k(1-itc_t)=\frac{1}{1+R_t}\,E\left[\left(1-\tau_{t+1}^{CP}\right)P_{t+1}\ mpk_t+P_{t+1}^K\,(1-\delta)\left(1-\tau_{t+1}^{CG}\right)\middle|\Im_t\right]$$

32

- a fall in investment tax credits: raises the MC of purchasing capital, so investment falls.
- a rise in corporate profit taxes: lowers the MB of capital, so investment falls.
- a rise in capital gains: lowers the MB of capital, so investment falls.
  - a fall in accelerated depreciation has the same effect as a rise in capital gains.

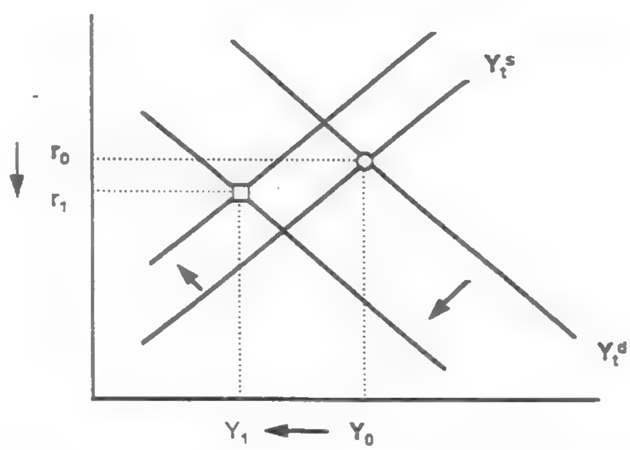
33

Effects of distortionary taxes on output and interest rates

- Consider a permanent increase in marginal tax rates and no change in government spending (perhaps to retire old debt).
  - fewer labor hours since the tax is on labor (less supply in the goods market),
  - less consumption for the young since the PDV of income has decreased (less demand in the goods market),
  - less demand for capital since the return on investment falls (less demand in the goods market).

34

Goods market for permanent increase in marginal tax rates



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Reconsidering Ricardian Equivalence Theory

- To examine this consider a temporary deficit financed marginal tax decrease (which will be met with increased future tax rates).
- Instead of having no effects on real output and interest rates (as it was with lump-sum taxes), the marginal tax decrease results in increased supply (agents work more) and possibly increased demand in the goods market (more capital investment if the future tax rise is after capital has depreciated).
- Output rises and real rate effect is uncertain.

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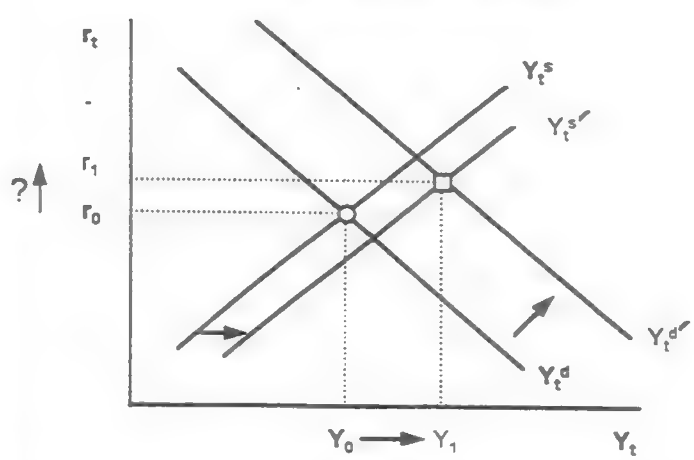
Goods market for a temporary decrease in marginal tax rates



I I

The Open Economy

Closed vs. Open Economies

- Until now, we have analyzed an economy that doesn't interact with the rest of the world (i.e. a closed economy).
  - a good description of the U.S. through the 1950's when exports/GNP = 0.05
  - Now we analyze an economy that interacts in goods, credit, and money markets
  - U.S. is moving toward this (exports/GNP = 0.1 in 1991)

Exchange Rate definitions

- Nominal exchange rate (e_t) is the number of foreign currency units that trade for one domestic currency unit (we'll assume the U.S.)

$$e_t \equiv \frac{\#\text{ of foreign currency}}{1\text{ dollar}}$$

- That is, the exchange rate is just the relative price of dollars in terms of foreign currency.
- If e_t increases it takes more foreign currency to buy a dollar (i.e. the dollar is more valuable & appreciates relative to the foreign currency)

Competitiveness and the real exchange rate

- What matters for competitiveness is not just the relative price of currencies, but also the prices of goods in the respective countries.

- The real exchange rate (s_t) is the number of foreign goods that trade for one domestic (U.S.) good

$$s_t \equiv \frac{e_t P_t}{P_t^f} \equiv \frac{\dfrac{\#\text{foreign currency units}}{1\$} \bullet \dfrac{\#\$}{1\text{ U.S. good}}}{\dfrac{\#\text{foreign currency units}}{1\text{ foreign good}}} \equiv \frac{\#\text{ foreign goods}}{1\text{ U.S. good}}$$

Why is the Real Exchange Rate a good proxy for Competitiveness?

- A country gains competitiveness when the price of its goods falls relative to its competitors.
- When the number of foreign goods that trade for 1 U.S. good falls, U.S. goods are "really" inexpensive and foreign goods are "really" expensive.
- U.S. citizens substitute out of foreign goods and foreigners substitute into U.S. goods.

Payments Definitions

- The current account measures trade in goods and services. The current account (in dollar terms) equals the trade balance plus the interest receipts/payments on net holdings of foreign bonds

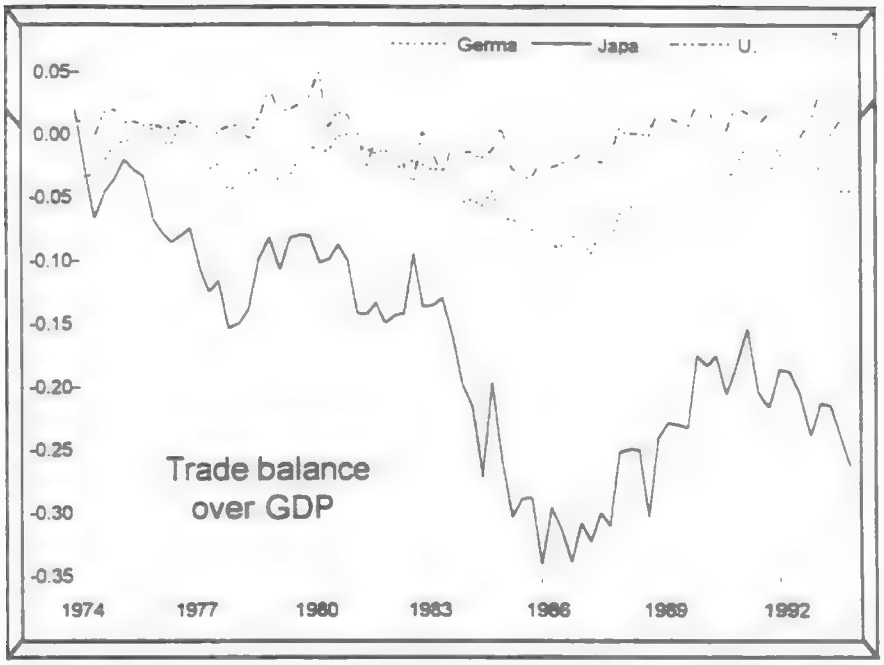
$$\text{Current Account} = P_t Ex_t - P_t^f Im_t / e_t + R_{t-1} B_{t-1}^f / e_t$$

where

Ex_t = exports of US real goods and services

Im_t = imports of foreign real goods and servcies

B^f_t = foreign bonds held by US citizens - US bonds held by foreigners (so if $B^f_t > 0$ means US is net creditor)



- The capital account measures changes in the stock of assets (bonds) across countries in nominal terms.

$$\text{capital account} = B_t^f - B_{t-}^f$$

- If there's a big inflow of savings (often called a capital inflow) where foreigners purchase more US assets than we purchase foreign assets, the US becomes indebted to the rest of the world (i.e. B^f_t-B^f_{t-1} becomes more negative).

The country's budget constraint

- Flows in goods across countries must be financed by flows of assets. When the U.S. runs a big trade deficit, we don't get the goods for free; we must provide assets (just claims to future U.S. goods) in return.
- The balance of payments measures a country's trade in goods and services as well as its trade in assets (PUT B's OTHER SIDE)

$$X_t - X_{t-1} + \left(B^f_t - B^f_{t-1}\right)/e_t = P_t Ex_t - P^f_t Im_t / e_t + R_{t-1} B^f_{t-1} / e_t$$

where X_t is the US Central Bank Holdings of foreign exchange reserves.

Balance of payments examples:

- Suppose the US runs a current account deficit of \$10 billion (that is $P_t Ex_t - P^f_t Im_t/e_t + R_{t-1}B^f_{t-1}/e_t = -\$10$ billion)
- If foreign exchange reserves are left unchanged, US citizens must issue bonds exceeding bonds issued by foreigners by \$10 billion (that is $(B^f_t - B^f_{t-1})/e_t = -\$10$ billion), so everything balances (i.e., -10 = -10).
- If foreigners were willing to accept only \$8 billion in bonds, then Fed reserves of foreign currency must be depleted by \$2 billion to assure balance (i.e. -2 -8 = -10).

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Open Economy definitions of Output and Expenditure

- (Nominal) GNP equals (nominal) GDP plus net factor income from abroad

$$P_t GNP_t = P_t Y_t + R_{t-1} B^f_{t-1} / e_t$$

- Using the expenditure approach to GNP accouting implies

$$P_t Y_t + R_{t-1} B^f_{t-1} / e_t = P_t (C_t + I_t + G_t) + P_t Ex_t - \frac{P^f_t Im_t}{e_t} + \frac{R_{t-1} B^f_{t-1}}{e_t}$$

12

The Market in Foreign Exchange

- Just as we study a market in (e.g.) apples where the quantity variable is apples and the price variable is the number of units of currency that trade for 1 apple, we could substitute US dollars for apples.
- That is, in the foreign exchange market that we will study, the quantity variable is dollars and the price variable is the exchange rate, e_t, the number of foreign currency that trade for a dollar.

Foreign exchange demand

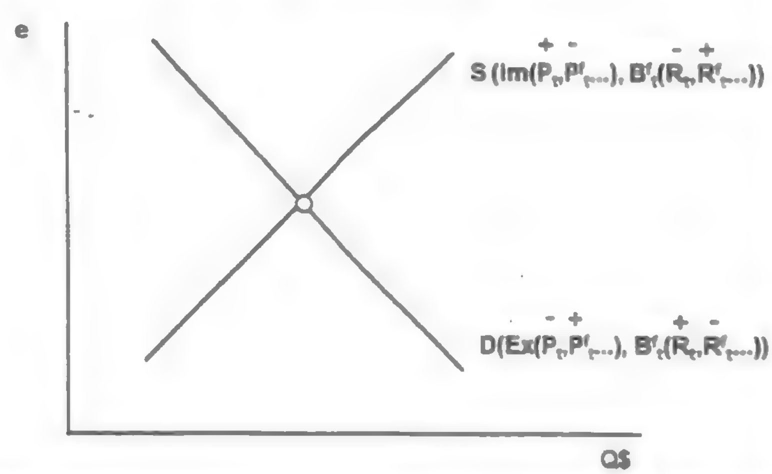
- Foreigners demand dollars in order to buy US goods and assets.
- Demand slopes downward since a decrease in e_t implies that US goods and assets are cheaper, so foreigners demand more US goods and assets and demand more dollars to purchase them (a substitution effect).
- Demand will shift if there are changes in domestic (foreign) prices or interest rates.

Foreign exchange supply

- US agents supply dollars to obtain foreign currency in order to buy foreign goods and assets.
- Supply slopes upward only if substitution effects dominate valuation (income) effects.

- Substitution effect: An increase in e_t implies that foreign goods and assets are cheaper, so US citizens demand more foreign goods and assets and supply more dollars in order to obtain the foreign currency.
- Valuation effect: An increase in e_t means every dollar buys more foreign currency, so US citizens don't need to supply as many dollars to the get the foreign goods and assets.
- Supply will shift if there are changes in domestic (foreign) prices or interest rates.

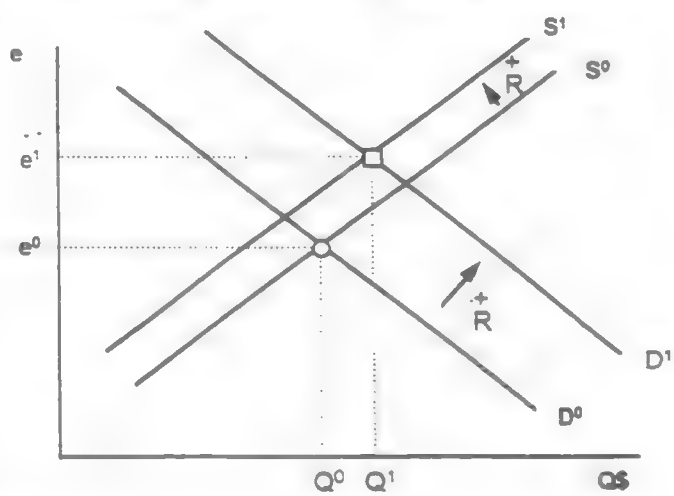
The foreign exchange market



Types of exchange rate systems

- In a flexible exchange rate system, Central Banks are not required to stablize the exchange rate in response to shocks.
- Example: If US interest rates rise and foreigners demand dollars to buy high-yielding US bonds, this increase in demand will appreciate the dollar unless the Fed acts.

Flexible exchange rate system



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- In a fixed exchange rate system, Central Banks stand ready to buy or sell reserves (intervene) in response to shocks to clear the market at the fixed price, $\bar{e}_t$.
- In response to the increased demand for dollars, the Fed must supply dollars and receive foreign currency reserves.

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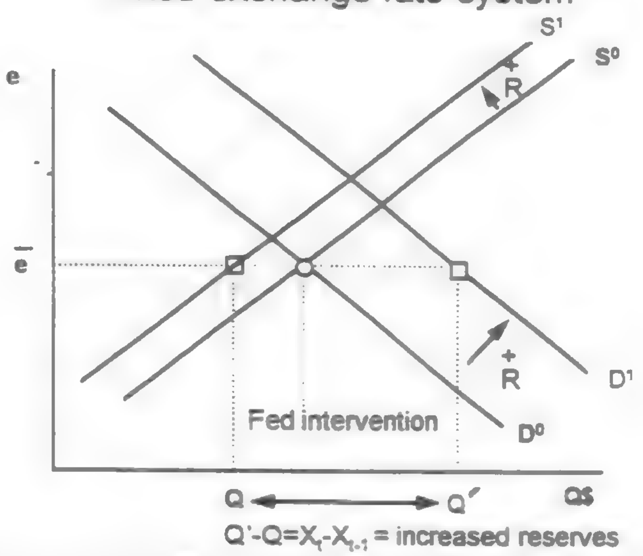
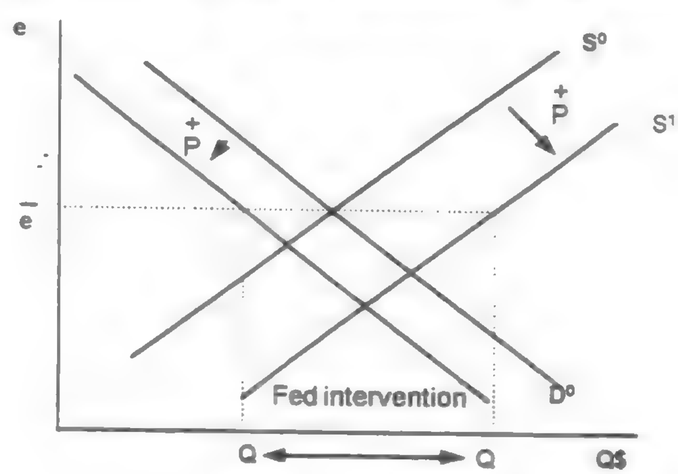
Fixed exchange rate system



- Notice that any increase in X_t implies an increase in M_t by the identity (M=X+DC) so with fixed exchange rates, Central Banks lose control of their monetary policy.
- This loss of control brought down the system of fixed controls that had existed until the early 1970's. With increasing inflation at home in the late 60's and early 70's, US citizens wanted the cheaper foreign goods and the supply of dollars on the market increased. The Fed bought up dollars to maintain the fixed exchange rate until the Fed virtually ran out of foreign reserves.

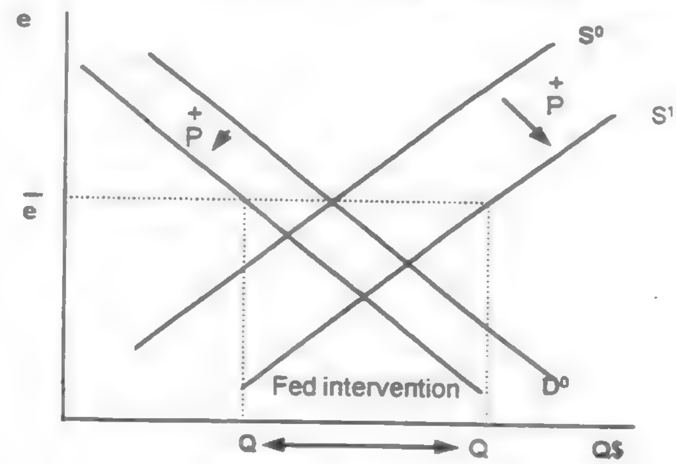
The end of the fixed exchange rate system



$Q'-Q=X_t-X_{t-1}$ = decreased reserves

23

The end of the fixed exchange rate system



$Q'-Q=X_t-X_{t-1}$ = decreased reserves

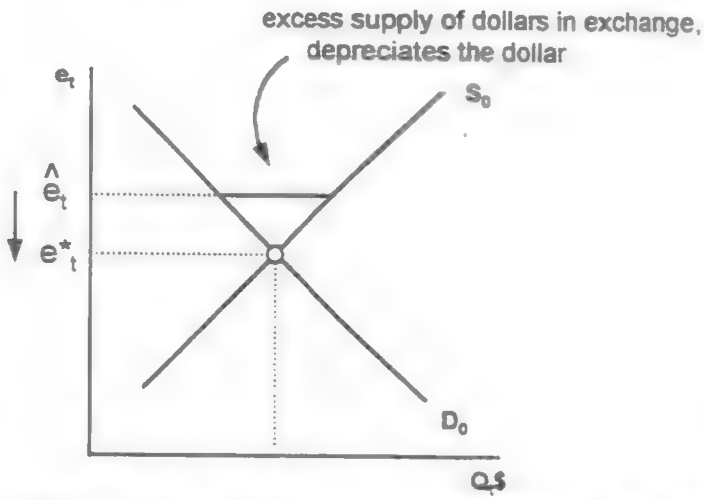
24

The Absence of Goods Market Arbitrage Condition

- Consider the following two strategies:
  - $1 buys $1/P_t$ units of U.S. goods
  - $1 buys e_t units of foreign currency, which buys e_t/P^f_t units of foreign goods.
- If $\hat{e}_t/P^f_t > 1/P_t$, it is cheaper to buy goods in the foreign country. US citizens would provide an excess supply of dollars in exchange for foreign currency in order to purchase cheap foreign goods. The dollar depreciates from $\hat{e}_t$ to e^*_t until $e^*_t/P^f_t = 1/P_t$ where the excess supply is choked off.

25

Pricing off Goods Market Arbitrage



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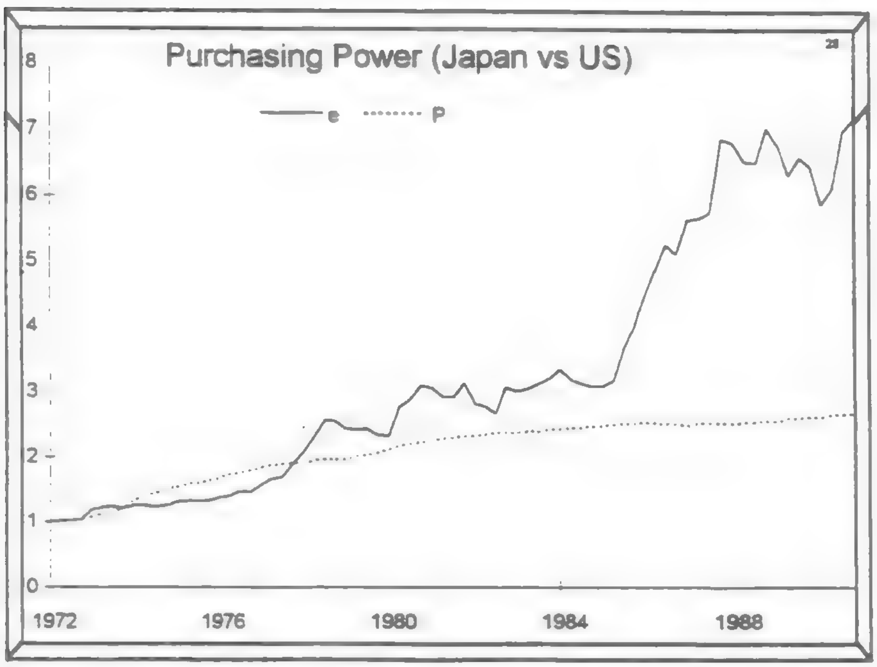
Absence of Goods Market Arbitrage and Purchasing Power Parity

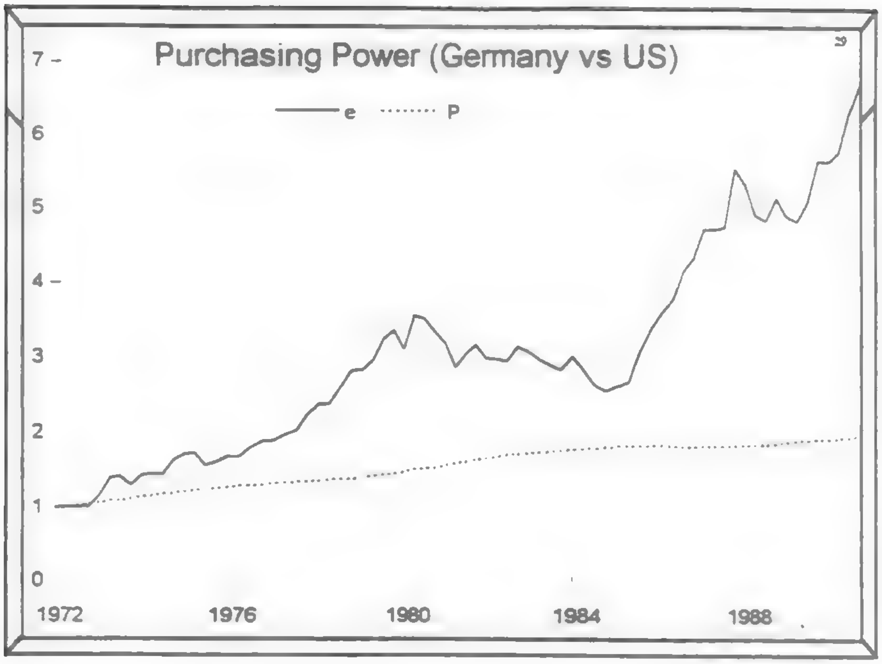
- If there are no trade barriers or transportation costs, the absence of arbitrage opportunities means that the foreign currency price of a bundle of goods in the US should equal the foreign currency price of an identical bundle in the foreign country. This pricing condition is known as <u>Purchasing Power Parity</u> (PPP).

$$e_t \cdot P_t = \frac{\#\text{foreign currency units}}{1\$} \cdot \frac{\#\$}{1\text{ U.S. bundle}} = \frac{\#\text{foreign currency units}}{1\text{ foreign bundle}} = P_t^f$$

Empirical evidence for PPP

- If PPP held, then the foreign currency price of U.S. goods (e_tP_t) should be closely related to the foreign currency price of foreign goods (P^f_t).
- Evidence for PPP is quite slim as the following graphs show (i.e. if PPP held, the two curves should be tied together).
- The high foreign currency price of US goods in the diagrams for Japan and Germany is one explanation for the high trade deficits we have experienced in the last 10 years.




Purchasing Power (Germany vs US)
e
P
7
6
5
4
3
2
1
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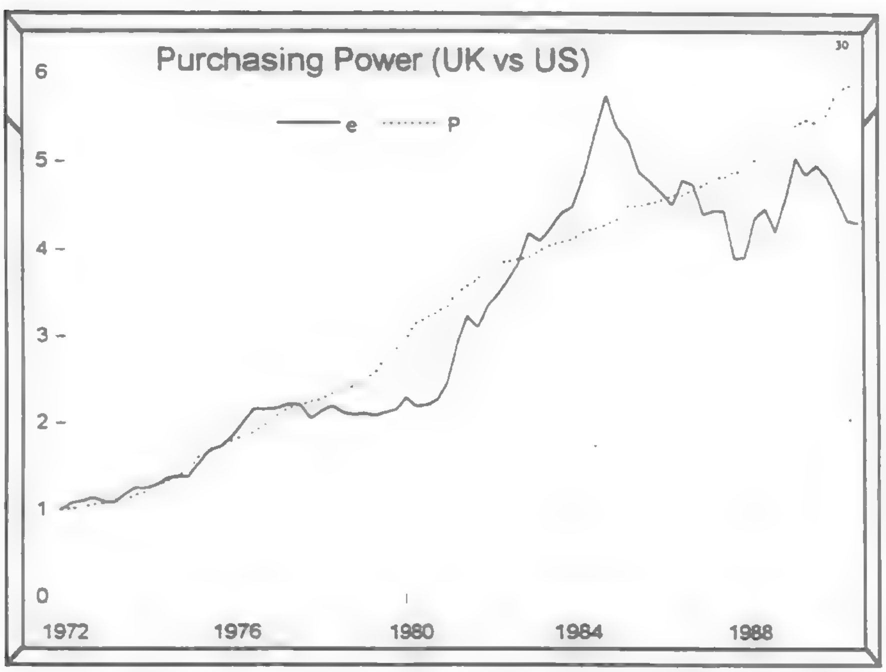
1972
1976
1980
1984
1988


Purchasing Power (UK vs US)
e
P
6
5
4
3
2
1
0
1972
1976
1980
1984
1988

31

The Absence of Bond Market Arbitrage Condition

- Consider the following two strategies:
  - $1 buys a U.S. bond at t which yields $\$(1+R_t)$ at t+1
  - $1 buys e_t foreign bonds at t, which yield $e_t(1+R^f_t)$ foreign currency at t+1. This foreign currency return can be expected to yield a dollar return of $e_t(1+R^f_t)/e_{t+1}$ at t+1.

32

Absence of Bond Market Arbitrage (cont)

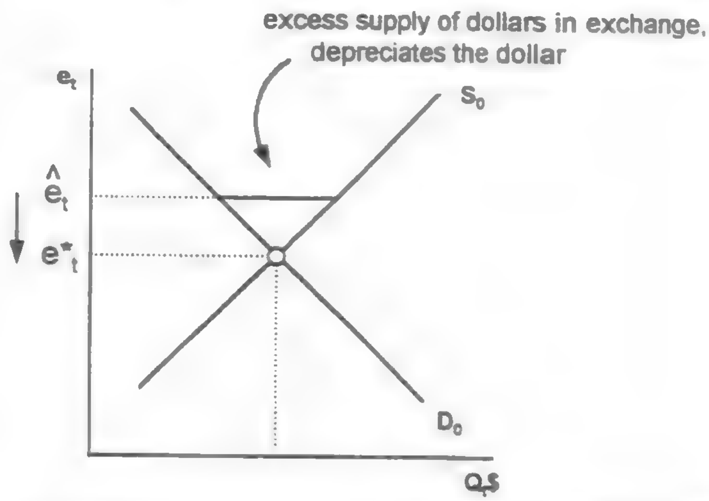
- If $(1+R_t) < E\left[\frac{\hat{e}_t(1+R^f_t)}{e_{t+1}} \mid \Im_t\right]$, risk neutral US savers will buy foreign bonds. To do this, US citizens would provide an excess supply of dollars in exchange for foreign currency in order to purchase foreign bonds. The dollar depreciates from $\hat{e}_t$ to e^*_t until

$$(1+R_t) = E\left[\frac{e^*_t(1+R^f_t)}{e_{t+1}} \mid \Im_t\right]$$

where the excess supply is choked off.

33

Pricing off Bond Market Arbitrage



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The Absence of Bond Market Arbitrage and Uncovered Interest Parity

- If there are no credit controls or transaction costs and savers are risk neutral, the absence of arbitrage opportunities in the bond market means that the return on US bonds should equal the expected dollar return on foreign bonds

$$(1+R_t) = E\left[\frac{e_t(1+R_t^f)}{e_{t+1}} \,|\Im_t\right]$$

- This is known as <u>Uncovered Interest Rate Parity</u> (UIP).

35

UIP (cont.)

- We can transform the UIP equation to:

$$\text{expected \% change in } e_t = R_t^f - R_t$$

- This says that if foreign nominal interest rates are higher than U.S. nominal interest rates, the only reason savers would hold U.S. bonds is that they expect the dollar will appreciate over the term of their foreign bond purchase (in which case the high yielding foreign bond would not be converted back to many dollars).

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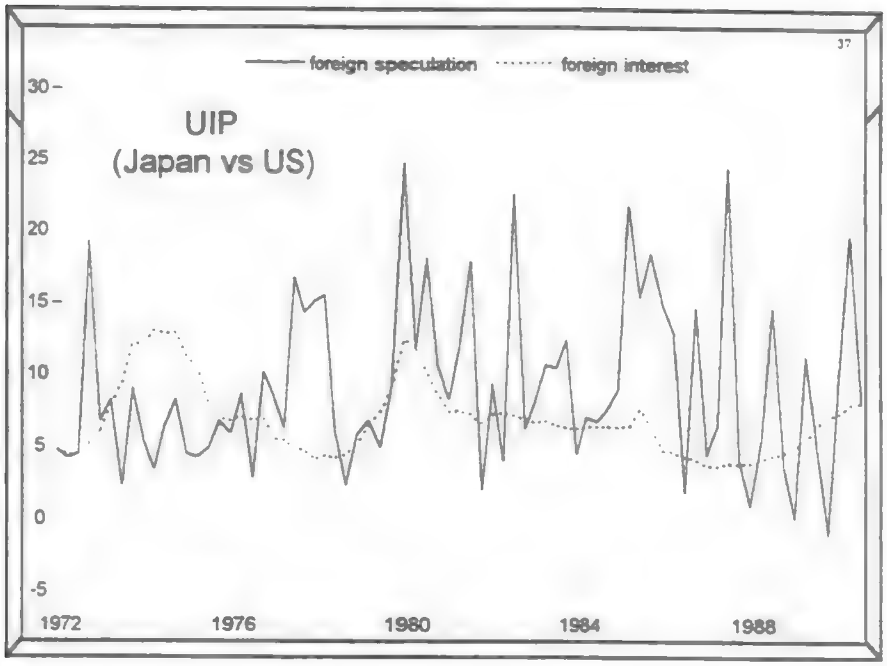
Empirical Evidence for UIP

- If UIP held, then the foreign currency return on U.S. bonds (R_t + expected appreciation or depreciation of nominal exchange rates) should be closely related to the foreign currency return of foreign bonds (R^f_t).
- Evidence for UIP is quite slim as the following graphs show (i.e. if UIP held, the two curves should be tied together).
- One problem is that speculators may not be risk neutral; the difference between the two curves may be interpreted as a risk premium.



foreign speculation
foreign interest
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UIP
(Japan vs US)
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25
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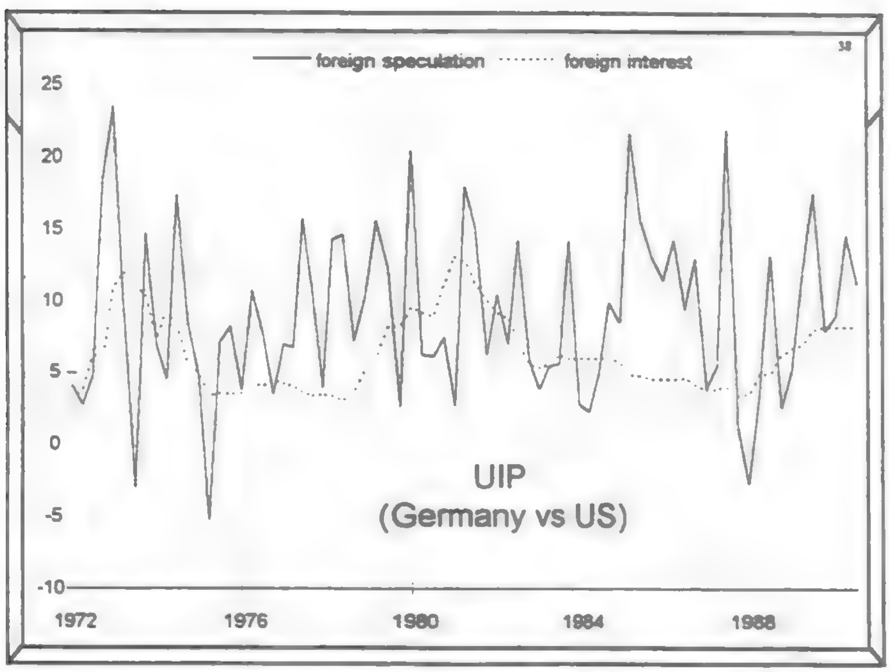

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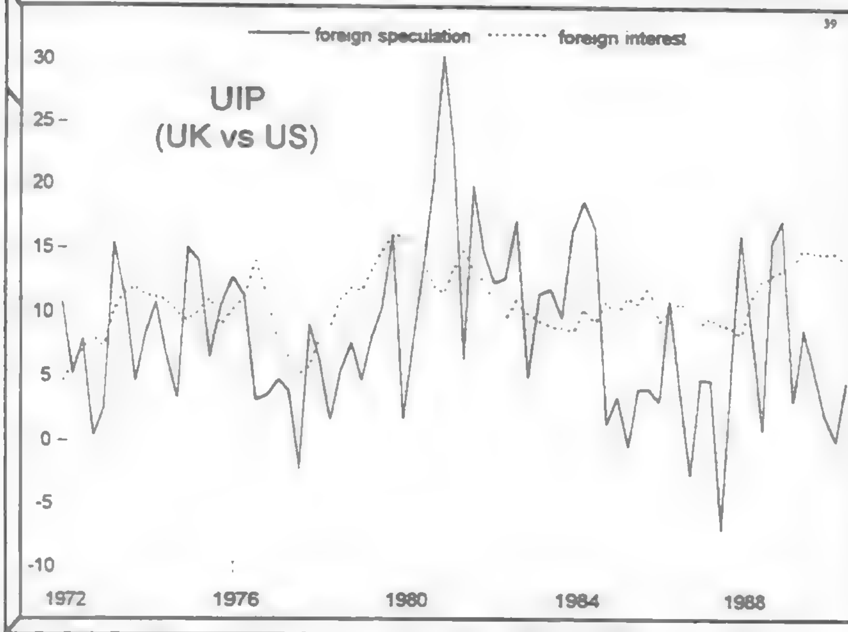

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The Forward Market in Foreign Exchange

- One way to get around the risk involved with future exchange rate movements alluded to above is to cover your position in the forward market. That is, write a contract to buy or sell future currency at a price determined today, f^1_t, where

$$f^1_t = \frac{\text{\# foreign currency at t+1}}{1\$}.$$

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Covered Interest Parity

- With perfect asset markets, the absence of arbitrage opportunities implies the dollar return on US bonds equals the covered return on foreign bonds

$$(1+R_t) = \frac{e_t(1+R_t^f)}{f_t^1}$$

- This is called covered interest parity (CIP) and is one way that forward rates get "priced" given the availability of all other information.

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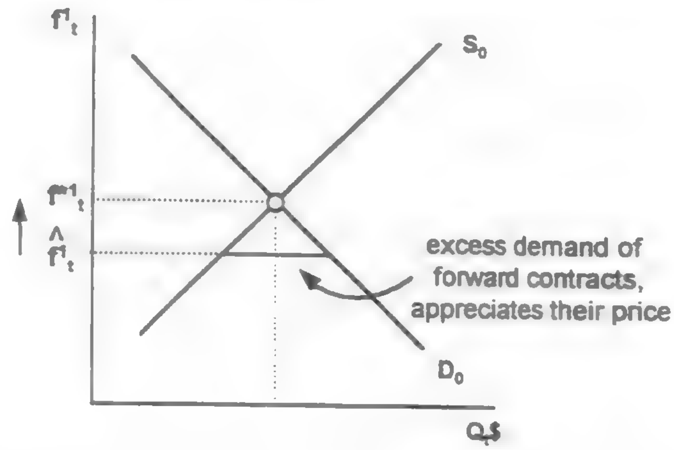
Forward Rates as Predictors of Future Spot Exchange Rates

- Suppose $\hat{f}^1_t < E[e_{t+1} | \mathcal{I}_t]$.
- Then a risk neutral speculator will contract at t to buy dollars in the forward market at t+1 at a low price and sell dollars in the spot market at t+1 at an expected high price.
- This excess demand for forward contracts will raise the price from $\hat{f}^1_t$ to f^{*1}_t until $f^{*1}_t = E[e_{t+1} | \mathcal{I}_t]$.

43

Pricing off Forward Market Arbitrage



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The Absence of Forward Market Arbitrage and Forward Rates as Predictors

- With perfect asset markets and risk neutral speculators, the forward rate should equal the expected future spot exchange rate

$$f^1_t = E[e_{t+1} | \mathcal{I}_t].$$

- This equality is known as the <u>unbiased forward rate hypothesis</u>. It says that the forward rate should be an efficient predictor of future spot rates.

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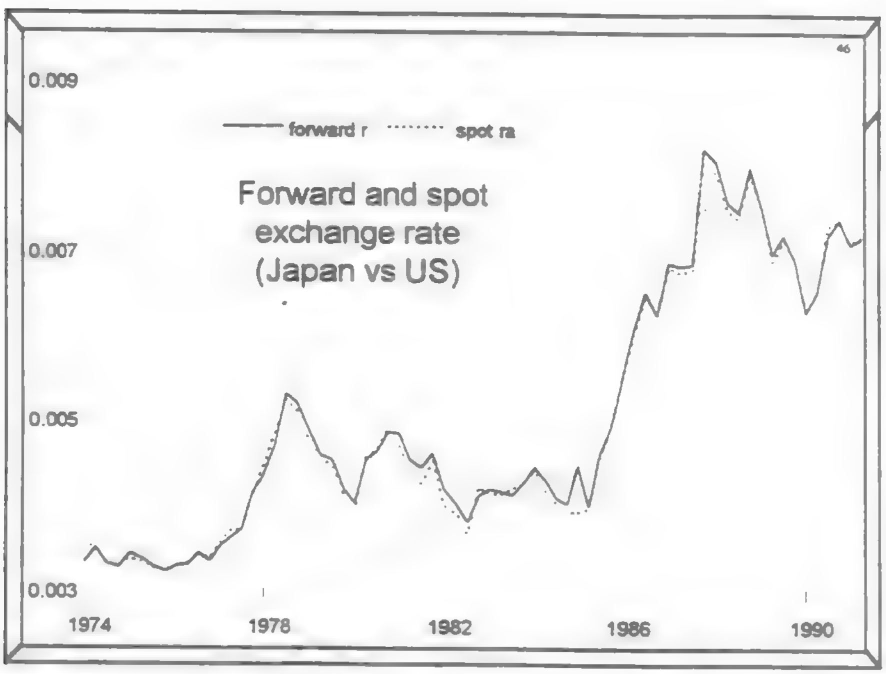
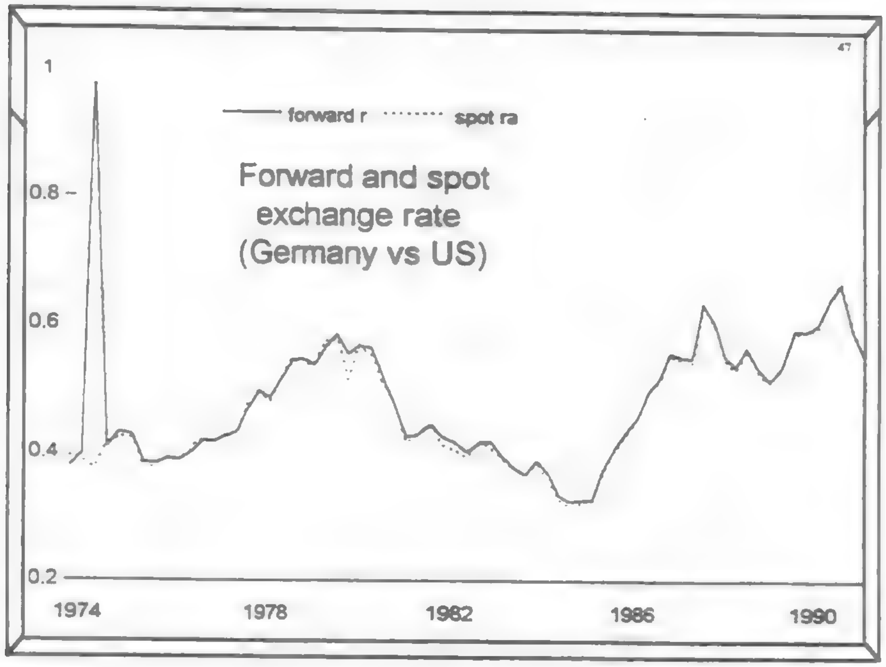
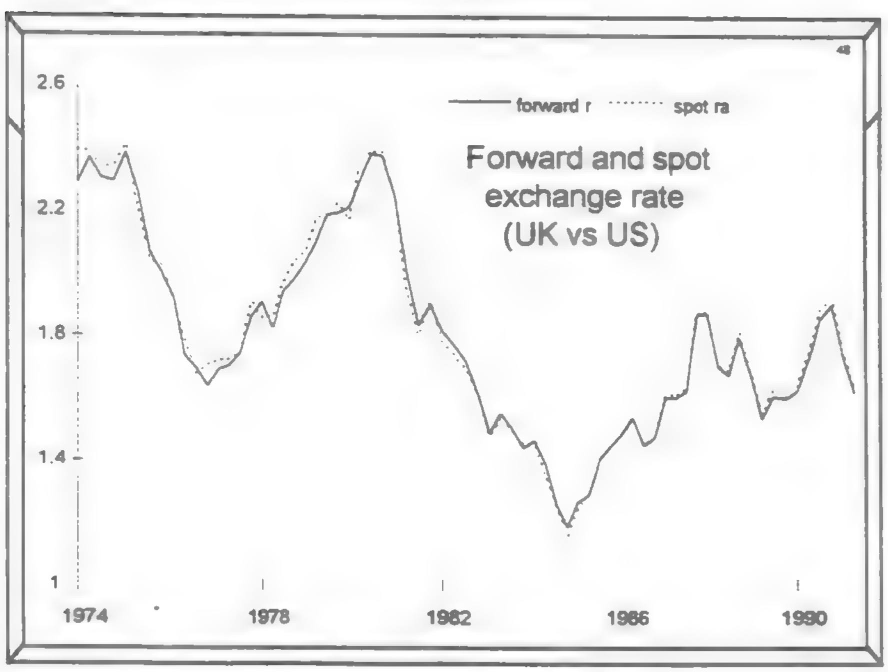
Empirical Evidence on Forward Rates as Predictors of Future Spot Rates

- In regressions of spot rates on lagged forward rates, you found that the constant term was insignificantly different from 0 and that the slope coefficient was insignificantly different from 1 as hypothesized. This provides evidence that forward rates are good predictors of future spot rates.
- However, mispredictions were found to be made consistently (i.e. the errors were slightly correlated over time). This calls into question the efficiency of the market.





47
forward r
spot ra
Forward and spot exchange rate (Germany vs US)
1
0.8
0.6
0.4
0.2
1974
1978
1982
1986
1990



48
forward r
spot ra
Forward and spot exchange rate (UK vs US)
2.6
2.2
1.8
1.4
1
1974
1978
1982
1986
1990

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Real Interest Rate Parity

- We can reformulate UIP in real terms. That is,

$$E[\%\Delta e_t + \pi_t - \pi^f_t \mid \mathcal{I}_t] = (R^f_t - E[\pi^f_t \mid \mathcal{I}_t]) - (R_t - E[\pi_t \mid \mathcal{I}_t])$$

  or the expected change in the real exchange rate equals the expected real interest differential.
- This is known as real interest rate parity.
- Differences in real interest rates in the next graph must then be associated with expected real exchange rate changes or risk premia.

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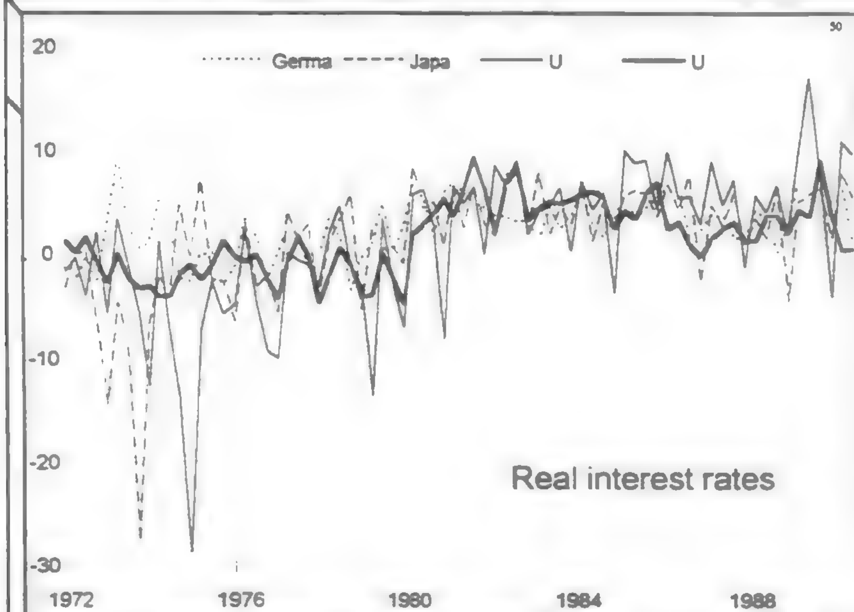

The Role of International Credit Markets and the Smoothing of Shocks

- Goods market clearing in a closed economy:

$$Y_t - C_t = I_t + G_t$$

or $\quad S_t^{priv} = Y_t - C_t - T_t = I_t - (T_t - G_t) = I_t - S_t^{govt}$

- This says that if private citizens want to smooth out a temporary shock to the economy (i.e. decrease S_t^{priv}), either the government must run budget surpluses (i.e. increase S_t^{govt}) or private citizens must eat the existing capital stock (i.e. decrease I_t).

- In the open economy, the goods market clearing condition is

$$Y_t + \frac{R_{t-1} B^f_{t-1}}{e_t P_t} = C_t + I_t + G_t + Ex_t + \frac{R_{t-1} B^f_{t-1}}{e_t P_t} - \frac{P^f_t Im_t}{e_t P_t}$$

domestic output + return on net foreign assets = domestic demand + net foreign demand

- This can be written $S_t^{priv} = I_t - S_t^{govt} - S_t^f$, where S_t^f is the net foreign savings in the US (the flip side of the current account).
- Now if private citizens want to smooth, they can buy goods from abroad and issue IOUs (i.e. foreigners increase S_t^f).

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Open Economy Responses to Productivity shocks:

- In a closed economy, an oil price shock that reduced domestic productivity resulted in excess demand for goods (private borrowing to smooth consumption) and a subsequent increase in the interest rate.
- In an open economy, if the shock affected all countries equally, then the effect is the same since all countries will have an excess demand for goods (borrowing) and no source of additional goods (savings).

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- In an open economy, if the shock affects only some countries (e.g. non-oil producing countries), then the unaffected countries supply goods in return for high yielding IOUs.
- This results in a trade deficit. During the oil crisis, there was an inflow of savings from the OPEC nations to the US.

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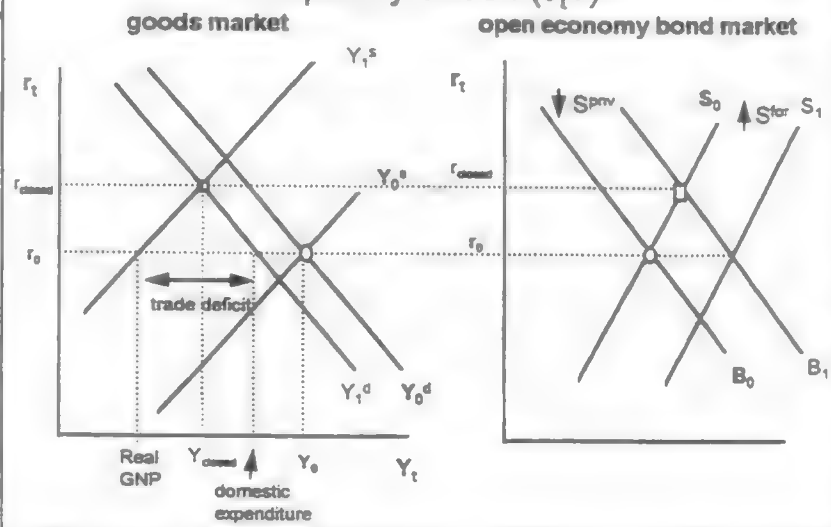
Open economy, country specific temporary shock ($\theta_t\downarrow$)



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Real exchange rate appreciation and the current account

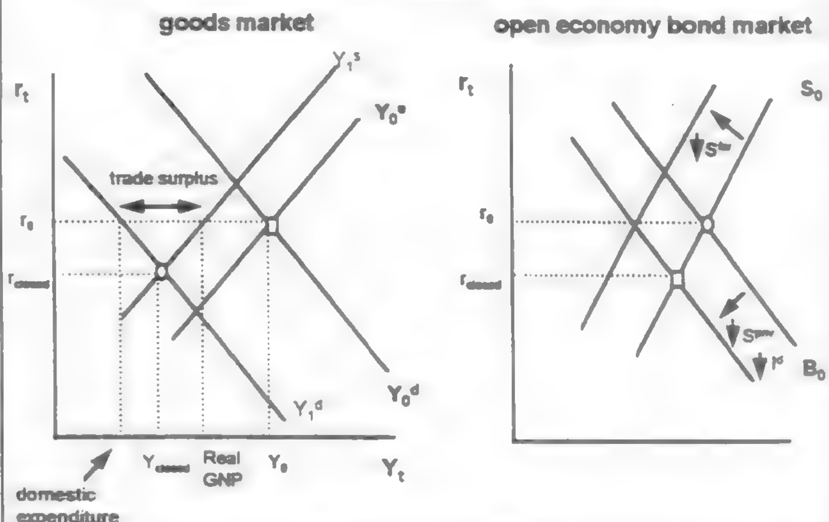
- Higher real U.S. interest rates that accompany the productivity shock induces foreigners to demand $ to buy U.S. bonds. The excess demand for $ in the foreign exchange market appreciates the $.

- Higher P_t, combined with higher e_t, makes U.S. goods less competitive, and is consistent with the trade deficit in the previous diagram.

Persistent, country specific negative productivity shock

- With a persistent negative shock, investment demand will drop significantly. This decreases aggregate demand substantially and can lead to lower U.S. real interest rates.
- Lower real rates generate a savings outflow and a depreciation of the $.
- In that case, the U.S. trade balance may actually improve.

Open economy persistent shock ($\theta_t, \theta_{t+1} \downarrow$)



Countercyclical Current Accounts

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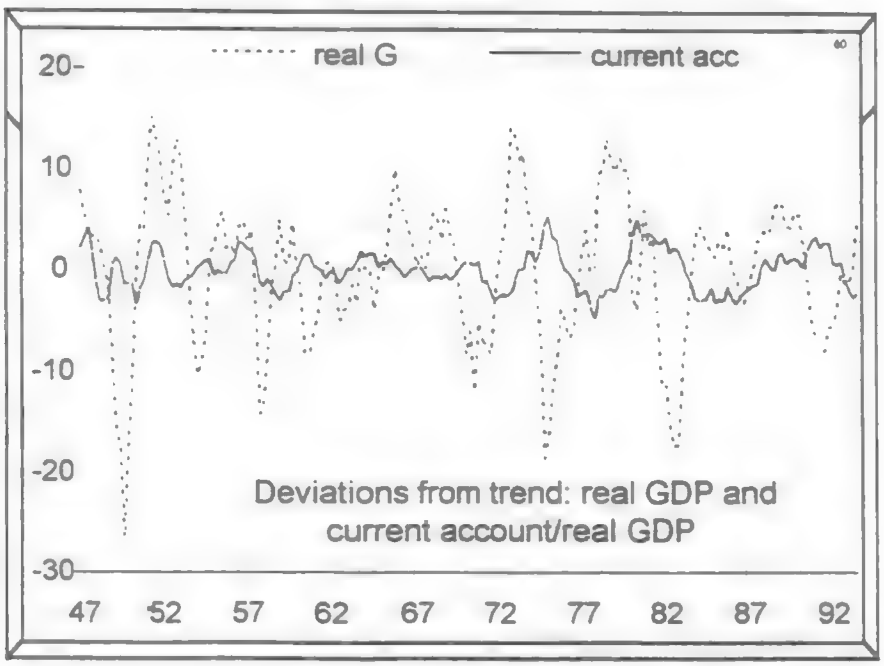
- We saw that if the technology shock was temporary, then both output and the current account fell (i.e. the current account would be procyclical).
- On the other hand, if the technology shock is persistent, then output falls but the current account rises (i.e. the current account would be countercyclical).
- In the data, the time series for real GNP and real current accounts are weakly countercyclical (correlation of -.21).



Temporary rises in Government expenditure and the Current Account

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- If the government runs a budget deficit (i.e. public savings falls) while private savings and investment are relatively unchanged, then the deficit must be financed by foreign savings.

- The rising real interest rate induces foreigners to save in the U.S. To do so, foreigners must buy $, which leads to an appreciation. The real appreciation leads to a worsening of the trade balance.

Open economy government expediture

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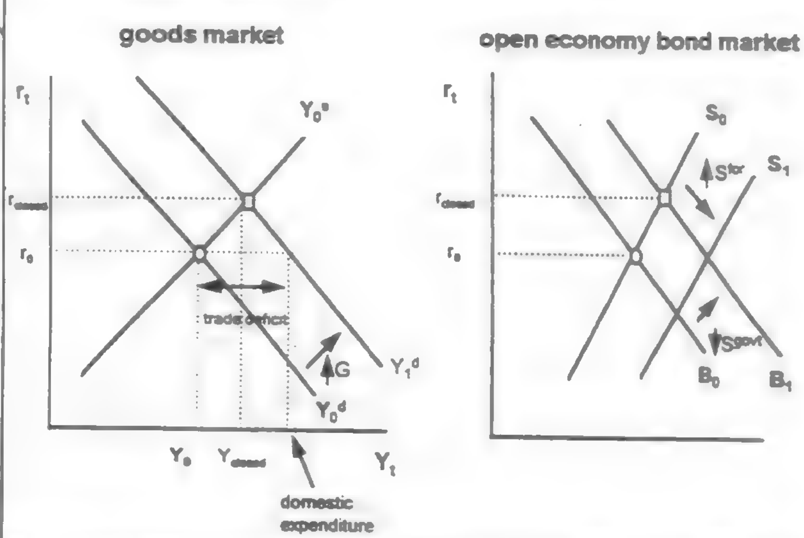

2) NOTES

2.A

Financial Markets and Economic Activity©

by

Dean Corbae

PREFACE

In the last twenty years macroeconomics and finance have converged. Much of the credit lies with the recent Nobel Laureate Robert Lucas of the University of Chicago. He made macroeconomists aware that the models they were using to do policy analysis were not *deep* enough; if agents (households, firms, banks,...) anticipate the actions taken by government they will alter their behavior and change the environment that the government action was originally based upon.[1] This meant that policy had to be set paying explicit attention to the optimizing and forward looking behavior of agents. But this is just what financial theorists had done for many decades. Lucas also contributed to the synthesis between macroeconomics and finance by providing a simple framework that both macroeconomists and financial economists could use to price assets such as stocks and bonds.[2]

In this set of notes, I try to make the synthesis of macroeconomics and finance clear. It is essential to understand how financial markets (in money, bonds, stocks, and foreign exchange) are inter-related with markets in goods and services. For instance, the real side of the economy can affect financial markets; consumer beliefs about the future state of the economy affects their spending/borrowing behavior and spills over to affect prices in the bond market. On the other hand, financial market movements can spill over to the real side of the economy; a Fed policy action in the short term money market which spills over to the bond, stock, and foreign exchange markets may affect firms' financing decisions.

I wish to thank Narayana Kocherlakota and Chuck Whiteman for their insights into the synthesis of macroeconomics and finance. I wish to thank Joong-Shik Lee for his input into the preparation of this material. I also wish to thank Jean Redlinger for her expert typing skills.

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[1]Lucas, R. (1976) "Econometric Policy Evaluation: A Critique", in The Phillips Curve and Labor Markets, K. Brunner and A. Meltzer, eds., Amsterdam:North-Holland.

[2]Lucas, R. (1978) "Asset Prices in an Exchange Economy", Econometrica, 46, p.1426-1445.

Table of Contents

Chapter I

INTRODUCTION

As managers of a firm, you are called on to maximize the expected present discounted value of your future profits. To do so, you must make informed predictions about the discount rate, the state of demand for your product, the state of your technology, and payments to factors of production such as labor and capital. Since we live in a global marketplace, the state of demand for your product may also be influenced by foreign competition. This amounts to forecasting such variables as interest rates, the aggregate price level (in relation to your firm specific price), wages, and exchange rates, to name just a few.

More specifically, let us define nominal (or dollar) profits as revenue minus cost. Nominal revenues are just the price of your product times your output. Your output is determined by your production function, which relates the state of your technology and your mix of labor and capital inputs employed to generate output. Nominal costs are just your wage bill on the employees that you hire and your rental (or purchase) of capital. We can thus write profits as:

$$profits_t = p_t \theta_t \, f\,(n_t \,, k_{t-1}) - w_t \, n_t - R_t \, k_{t-1}$$

where p_t is the nominal (or dollar) price of your good, θ_t is the state of your technology, $f(n_t,k_{t-1})$ is your mix of labor (n_t) and capital installed last period (k_{t-1}), w_t is the nominal wage you pay your employees, and R_t is the nominal rental cost of your capital. The price you charge for your good may be influenced by foreign competition; the dollar price of the foreign equivalent of your good is given by $e_t p_t^f$, where e_t is the nominal exchange rate and p_t^f is the foreign currency price of the good.

Your objective then, is to maximize expected present discounted value of profits:

$$E\left[profits_t + \frac{profits_{t+1}}{1+R_{t+1}} + \frac{profits_{t+2}}{1+R_{t+2}} + \dots \mid \mathfrak{I}_t \right]$$

where you form your forecasts or expectations ($E[\ \mid \mathfrak{I}_t]$) conditional on the information you have today (the information set is denoted $\mathfrak{I}_t$).

Now it should be apparent that the variables of interest to managers are of interest in our study of the macroeconomy. In macroeconomics, we focus on the determination of such quantities as real output (Gross National Product, denoted Y_t), aggregate employment (N_t), and the capital stock (K_t). We also focus on the determination of prices like the nominal interest rate (R_t), the aggregate price level (P_t) and its growth rate (inflation, denoted π_t), nominal wages (W_t), and exchange rates (e_t).

To understand the determination of such variables, we follow an approach somewhat broader than your managerial or micro- economics course. There, a particular industry is often the highest level of aggregation studied and prices outside that sector are taken as given. Here we study how factors in one sector spill over to other sectors and what implications this has for the joint determination of all prices. For instance, a Federal Reserve purchase of bonds in the money market may put upward pressure on wages in the labor market.

To accomplish this goal, we need a firm understanding of the behavior and interaction of the many agents in our economy: households, firms, the government, and the foreign sector. There is a common assumption we make about each of these agents' objectives; each set of agents cares not only about the present but also the future and faces constraints in their budgeting decisions. Without this assumption we would not observe real world occurrences of household saving and firm investment.

These notes are organized in the following manner. Chapter II provides necessary definitions for the study of financial markets and economic activity such as the output of an economy (real gross domestic product) and the short term nominal interest rate on a pure discount bond like a T-bill. Chapter III introduces the simplest possible model to understand the role of technology in the determination of real output. Chapter IV introduces the first asset market we will consider: a one-period bond which is a promise to return goods in the future. In this case, households (or firms) which have a current shortfall in income can smooth their consumption of nondurable or durable goods by borrowing from those households who wish to save. Chapter V integrates spending and saving decisions to determine prices (the real interest rate) and output (real GDP). Chapter VI adds another financial asset: currency. We study the household's portfolio decision between currency and bonds. This generates a demand for narrowly defined money which, when coupled with the supply of currency, determines the consumer price level. It is here that we learn the crucial distinction between real and nominal interest rates. Chapter VII studies the supply of money in more detail. In particular, we study the Fed Funds market and see how Fed changes in reserves affect the supply of narrow money which can translate into price level changes or inflation. Chapter VIII studies asset pricing (in particular bonds and stocks) under uncertainty. We focus on how expectations and macroeconomic risk play an important role in pricing. Chapters IX and X introduce firms explicitly into the framework. In chapter IX we study the decision by firms to hire labor and households' labor supply. The interaction of these two decisions determines the wage in the labor market. Chapter X studies a firm's capital purchase decision. Chapter XI studies fiscal policy: government expenditure on goods and services and its tax policy. Here it is critical to understand that the government faces a budget constraint like anybody else; any shortfall in receipts (known as the government budget deficit) must be financed by borrowing. Fiscal policy can have important impacts on financial markets and economic activity. Finally, chapter XII studies the open-economy. Here we see the interaction between foreign exchange markets and economic activity.

Chapter II

DEFINITIONS AND DATA

Before we can study the determinants of quantities and prices in our economy, we need to be familiar with the construction of such macroeconomic variables as GNP, interest rates and inflation. We also need to develop a terminology to describe data statistically.

A. Gross National Product.

We need some measure of output. What should we use?

Hypothetical Country of ASU

Quantities	Corn	Refrigerators
1993	50	5
1994	45	8
Prices		
1993	\$4	\$10
1994	\$4	\$10

Are simple quantities the correct measure of output?

The table would suggest people are better off in 1993 than 1994 because they produced lots of little items. Something seems wrong. A refrigerator is more valuable than a bushel of corn. This is why we use goods prices to tell us their relative value.

Definition *Nominal GNP* is the dollar value of all final current goods and services produced in a given year.

$$\text{i.e.}\quad \text{Nominal GNP}_t = \sum_{i=1}^{N} P_{i,t}Y_{i,t}$$

where $\sum_{i=1}^{N}$ denotes the sum from i=1 to N (ie. $P_{1,t}Y_{1,t}+P_{2,t}Y_{2,t}+\ldots+P_{N,t}Y_{N,t}$).

According to this measure people in ASU are better off in 1994 than 1993.

Nominal GNP in 1993 is given by \$4·50 + 10·5 = \$250
Nominal GNP in 1994 is given by \$4·45 + 10·8 = \$260

Is nominal GNP a good measure of the well-being of a country?

Quantities	Corn	Refrigerators
1992	50	5
1993	50	5
Prices		
1992	$3	$8
1993	$4	$10

Nominal GNP in 1992 is given by $3·50 + 8·5 = $190
Nominal GNP in 1993 is given by $4·50 + 10·5 = $250

So the dollar value of output is higher in 1993 than 1992. But did ASU really produce more in 1993? You don't eat prices.

Definition *Real GNP* is final goods and services produced in a given year valued relative to a base year set of prices (currently the base year is 1982).

$$\text{i.e. Real GNP}_t = \sum_{i=1}^{N} P_i^{'82} \, Y_{i,t}$$

Given our above data, if we use 1992 as the base year:

Real GNP in 1992 is given by $190 = 3·50 + 8·5
1993 is given by $190 = 3·50 + 8·5
so that we see real output has not changed even though nominal output did. This is why economists are more interested in studying real GNP than nominal GNP. Real GNP gives a more accurate assessment of goods production.

In this class we will focus not only on the level of real GNP, which is pictured in figure II.1, but also on the business cycle.

Definition The *business cycle* is a decline in real GNP (a contraction or recession) to a low point (a trough) followed by a recovery in real GNP (an expansion or boom) to a high point (a peak). We can view such a cycle as the deviations of real GNP from its trend. The official NBER classification of a recession is 2 quarters of negative real GNP growth.

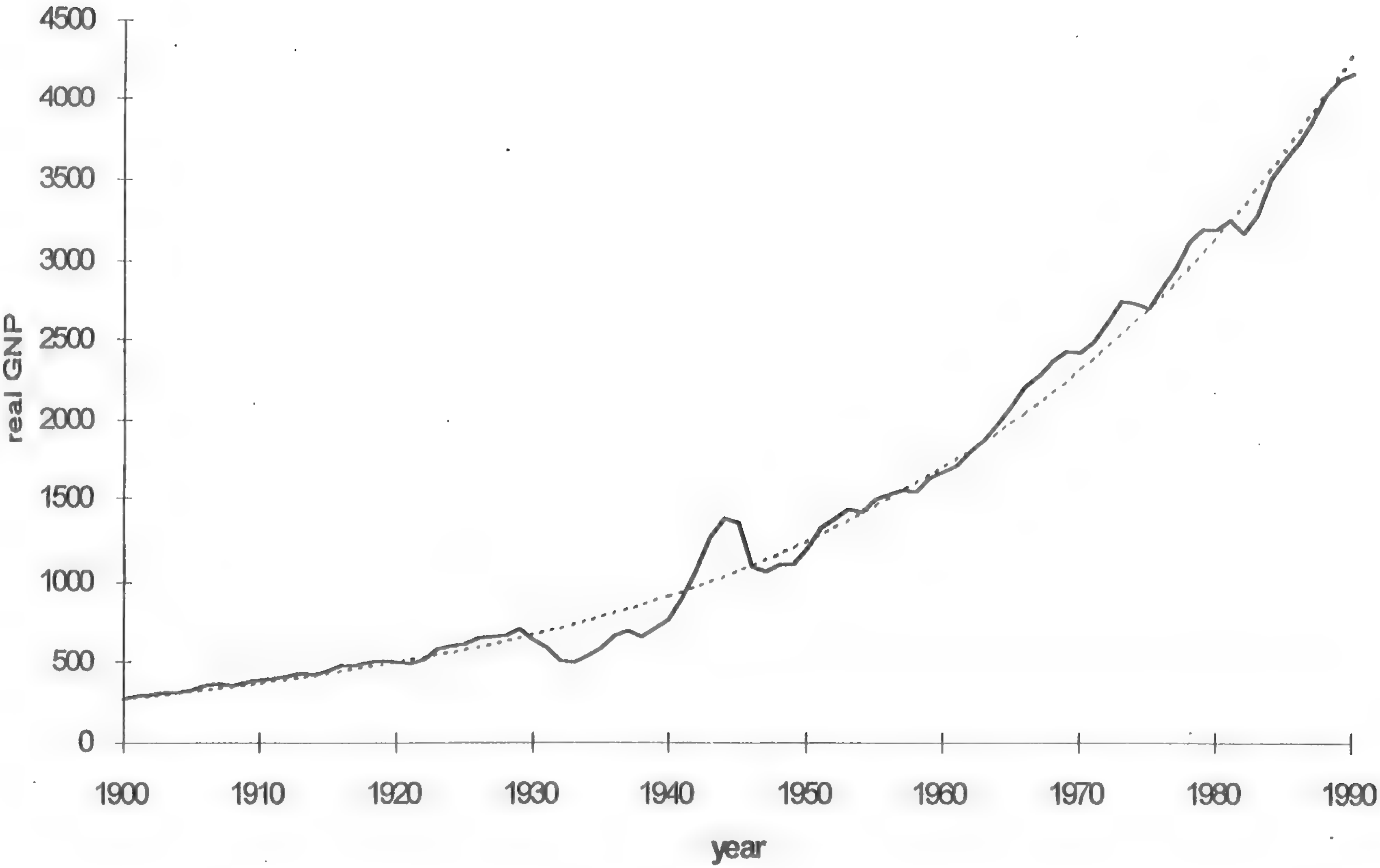

Figure II.1 Level of Real GNP

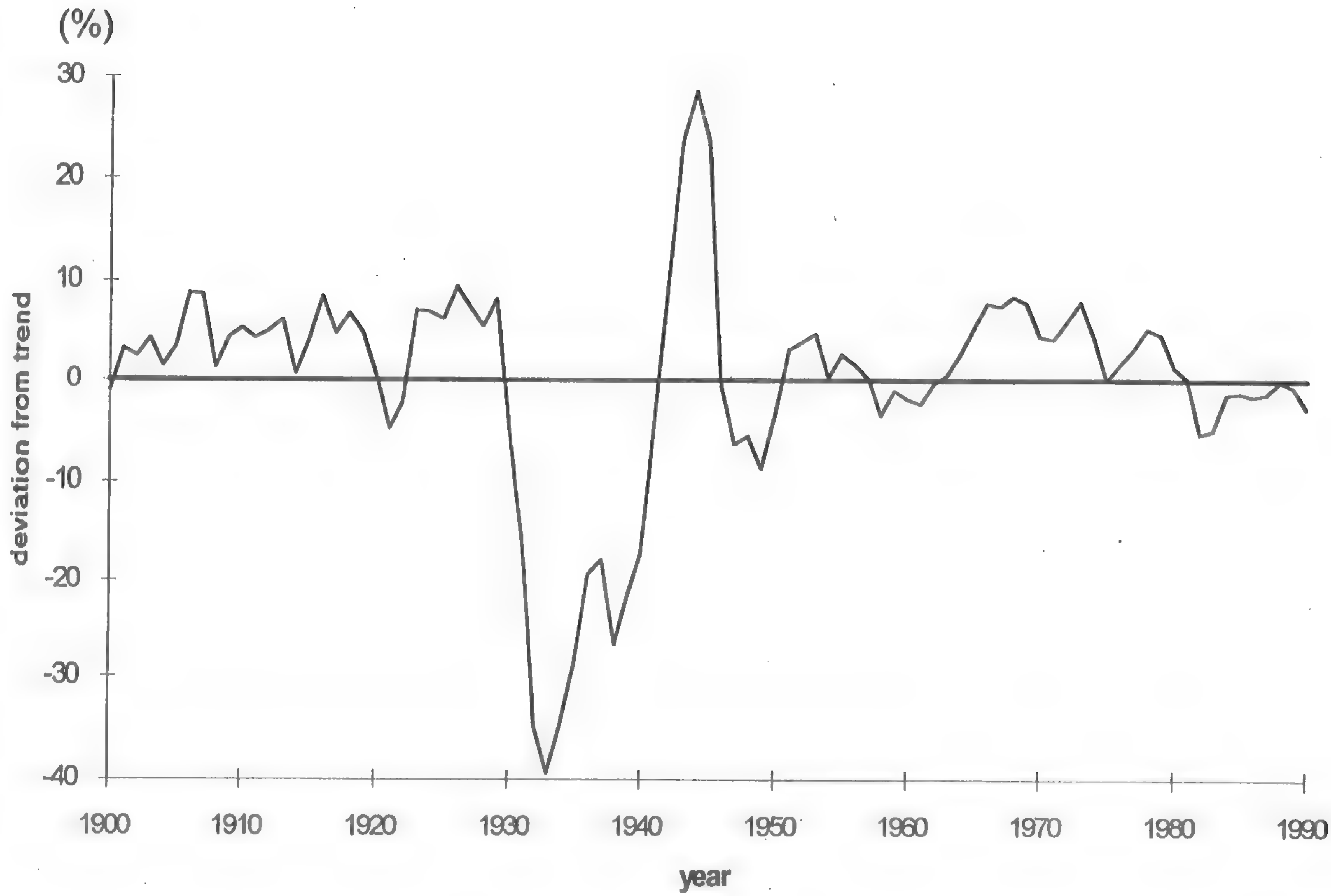

Figure II.2 Deviations from Trend: log Real GNP

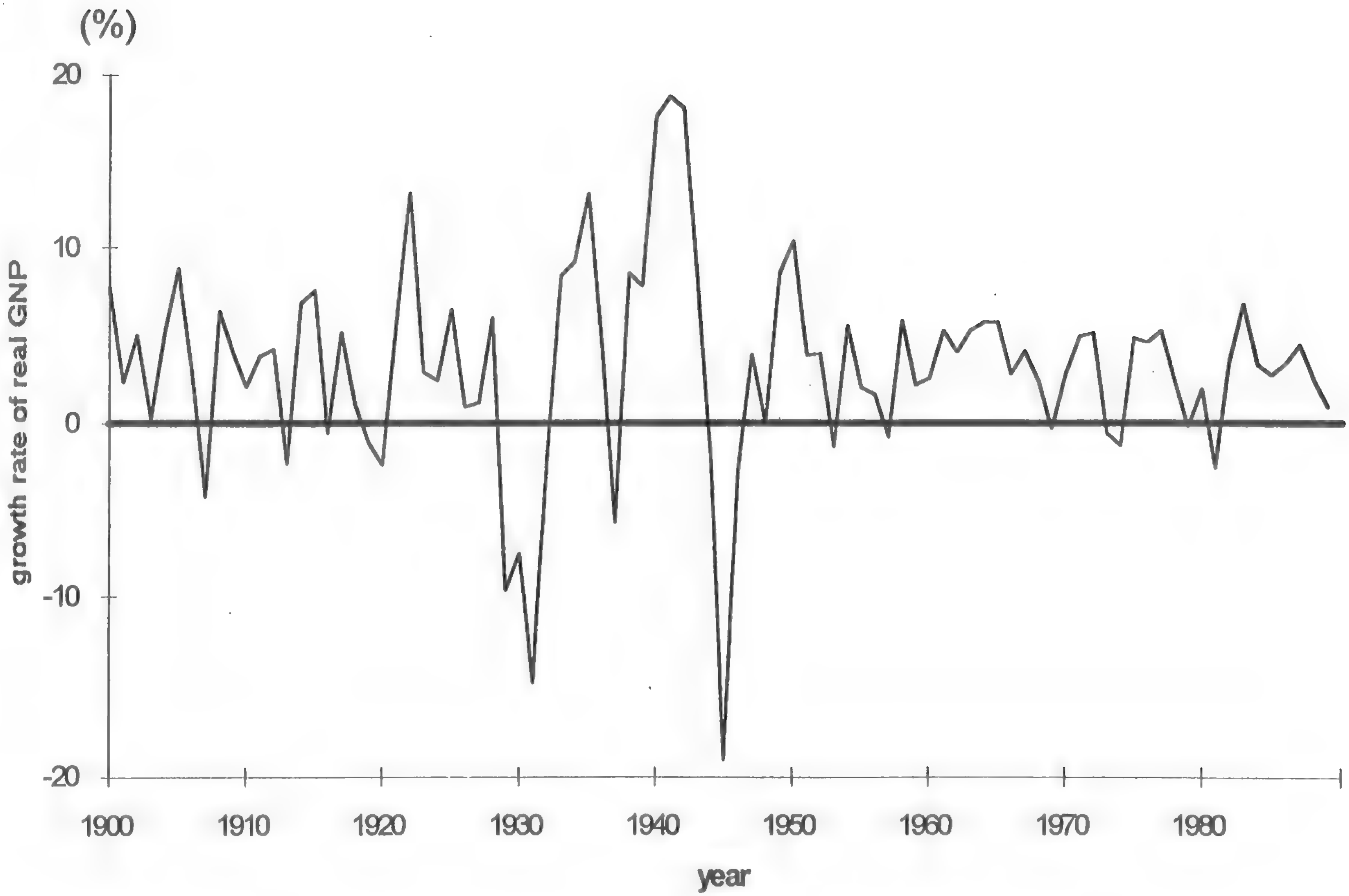

Figure II.3 Growth Rate of Real GNP

In figure II.2, we plot the deviations of real GNP from its log-linear trend. In figure II.3, we plot the growth rates of real GNP. The average (or mean) growth rate of annual U.S. real GNP over the sample period 1900 to 1991 was 3.27. The variability (or variance) of the growth rate was 32.20. (For the definitions of growth rate, mean, and variance see the appendix to this chapter)

B. MEASUREMENT.

There are three equivalent ways to measure GNP:
(a) Production
(b) Income
(c) Expenditure

Why are they equivalent? They are simply different aspects of the circular flow. See Figure II.4

Expenditure Identity

(1) $C + I + G + Ex - Im = Y$

which says that expenditure on private consumption, private investment, government purchases, and foreign consumption of U.S. goods must equal U.S. production of goods augmented by imports.

We now illustrate an important consequence of the expenditure approach. First, we need to know the uses of household disposable income:

(2) $C + S = Y - T$

which says that a household divides its after-tax income on either consumption or savings.

Equation (2) into (1) implies

$(G - T)$	$=$	$(S - I)$	$+$	$(Im - Ex)$
public dissaving	financed by	excess dom. private saving		foreign saving

The following table, using the identity derived from the expenditure approach, is suggestive that government budget deficits and trade deficits are related.

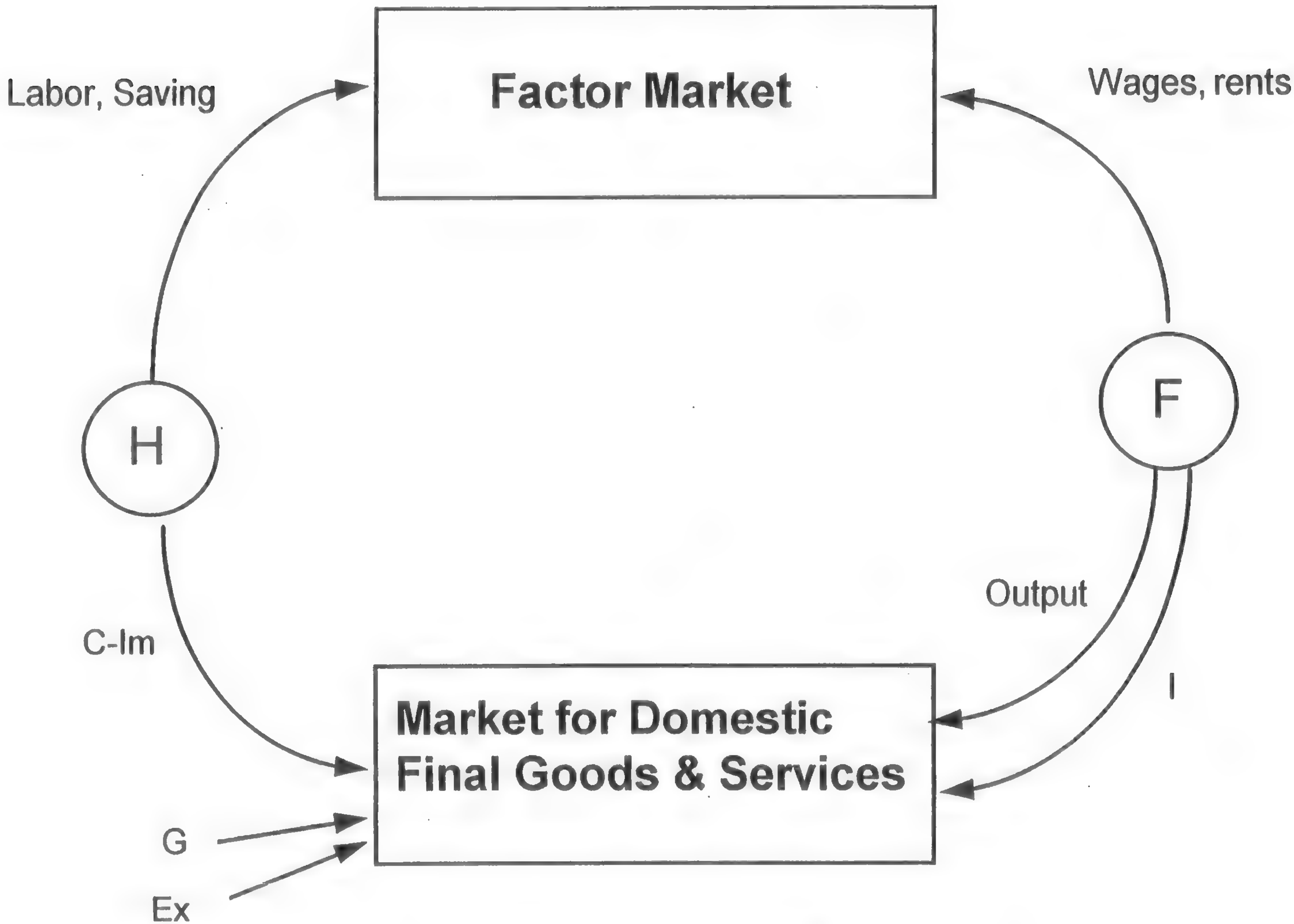

Figure II.4 Circular Flow of the Economy

United States (percentage of GNP)				
Year	Ex-Im	S	I	G-T
1981	0.3	18.0	16.9	1.0
1982	0.0	17.6	14.1	3.5
1983	-1.0	17.4	14.7	3.8
1984	-2.4	17.9	17.6	2.8
1985	-2.8	16.6	16.0	3.3
1986	-3.4	16.1	15.7	3.4
1987	-3.5	14.7	15.7	2.3
1988	-2.8	15.0	15.8	1.8

Source: *Economic Report of the President, 1989,* and U.S. Department of Commerce. *Survey of Current Business,* June 1989.

Japan (percentage of GNP)				
Year	Ex-Im	S	I	G-T
1981	0.4	35.5	31.3	3.8
1982	0.6	34.3	30.1	3.6
1983	1.8	33.8	28.3	3.7
1984	2.8	33.2	28.3	2.1
1985	3.7	32.9	28.4	0.8
1986	4.3	33.2	28.0	0.9
1987	3.6	32.0	29.0	-0.6
1988	2.8	32.4	30.7	-1.1

Source: Current account and general government deficit ratios from International Monetary Fund. *World Economic Outlook,* April 1989. Investment ratio calculated from GNP and investment data reported in Institute of Fiscal and Monetary Policy, Ministry of Finance (Japan), *Monthly Finance Review*, June 1989. Private saving ratio calculated as a residual.

C. INFLATION.

It's important to understand inflation because most contracts are written in nominal or $ terms.

To calculate inflation (denoted π)

(a) specify a bundle of goods
(b) cost in base year
(c) cost in future year
(d) the percentage change (% Δ) is π

Consider 3 different bundles:

(a) All goods in ASU in 1992

1992 $190

(250-190)/190=.32

1993 $250

(b) Bundle of 10 units of corn in 1992

1992 $30

(40-30)/30=.33

1993 $40

(c) Bundle of one refrigerator in 1992

1992 $8

(10-8)/8=.25

1993 $10

Hopefully you now appreciate that what bundle we choose implies different inflation rates.

In the U.S. we consider three different measures:

(a) all goods - GNP deflator
(b) typical consumer goods - Consumer Price Index (CPI)
(c) typical firm inputs - Producer Price Index (PPI)

In Figure II.5 we plot the CPI, and in Figure II.6 we plot its growth rate (ie. the inflation rate). The average (or mean) annual inflation rate over the sample period 1900 to 1990 was 3.24%. The variability (or variance) of inflation was 27.62.

D. INTEREST RATES.

When I talk about interest rates in class, I typically mean 1 year U.S. Treasury bonds. Just as with our definition of GNP, we will be concerned with the distinction between real and nominal interest rates. The nominal interest rate is posted everyday in the Wall Street Journal. Nominal interest rates range from 3% in the U.S. to over 100% in Russia. Are borrowing costs *really* higher in Russia? We will address this type of question later in the course.

In Figure II.7 we plot the 3 month nominal interest rate. In Figure II.8 we plot the real interest rate. The average (or mean) annual nominal interest rate over the sample period 1931 to 1990 was 3.80%. The variability (or variance) of nominal interest rates was 11.80. The mean annual real interest rate over the sample period 1931 to 1990 was .21%. The variance of real interest rates was 18.02.

There is an important identity between bond prices & and the nominal interest rate (denoted R).

Suppose a bond promises the buyer \$F one year from now and its current price is \$$P^B$. What is the dollar (nominal) return (R)?

$$R = \frac{F-P^B}{P^B} \quad or \quad P^B = \frac{F}{1+R}$$

so there's an inverse relation between R & P^B. Whenever the Wall Street Journal reports that bond prices have fallen, that means nominal interest rates have risen.

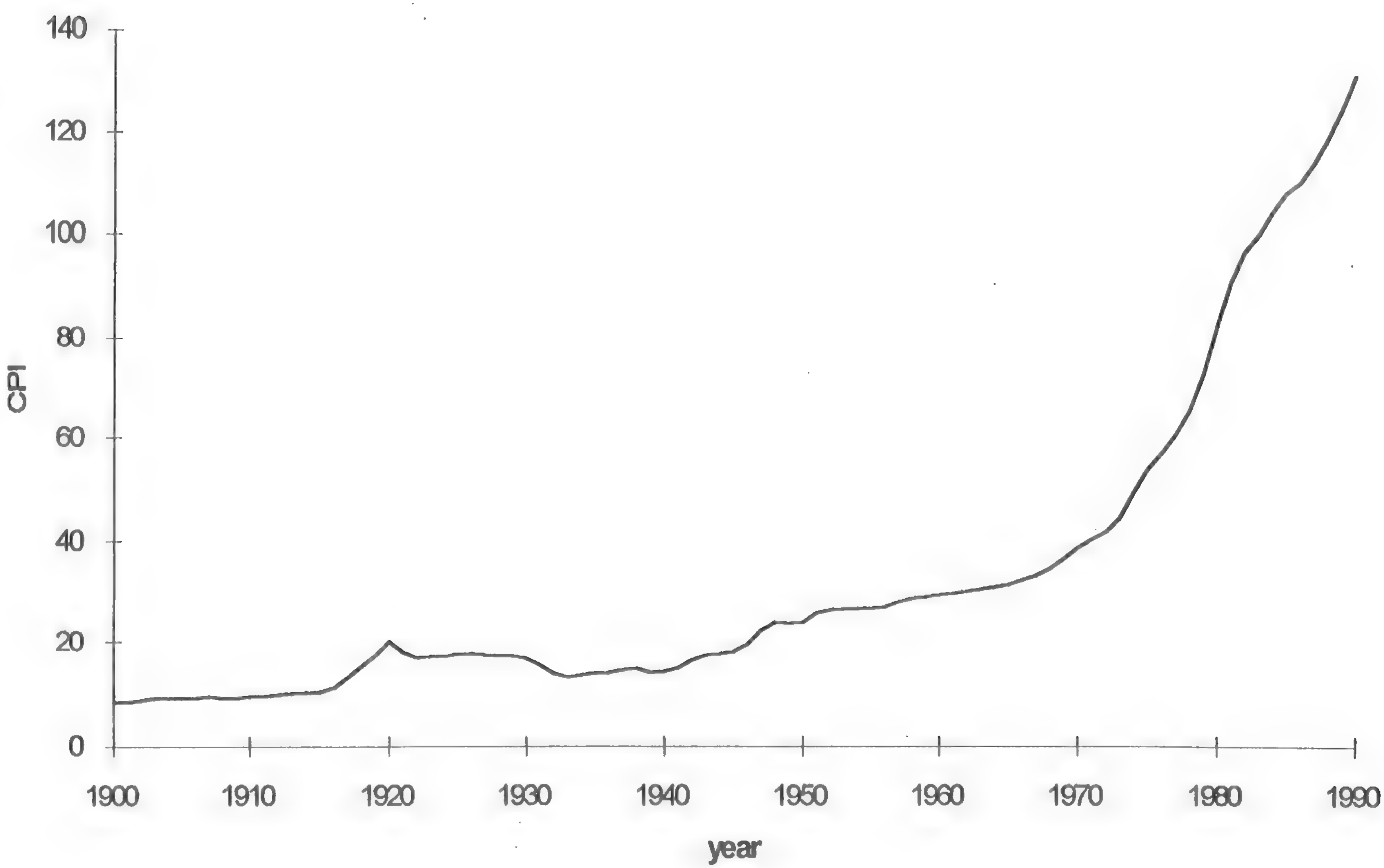

Figure II.5 Consumer Price Index(1985=100)

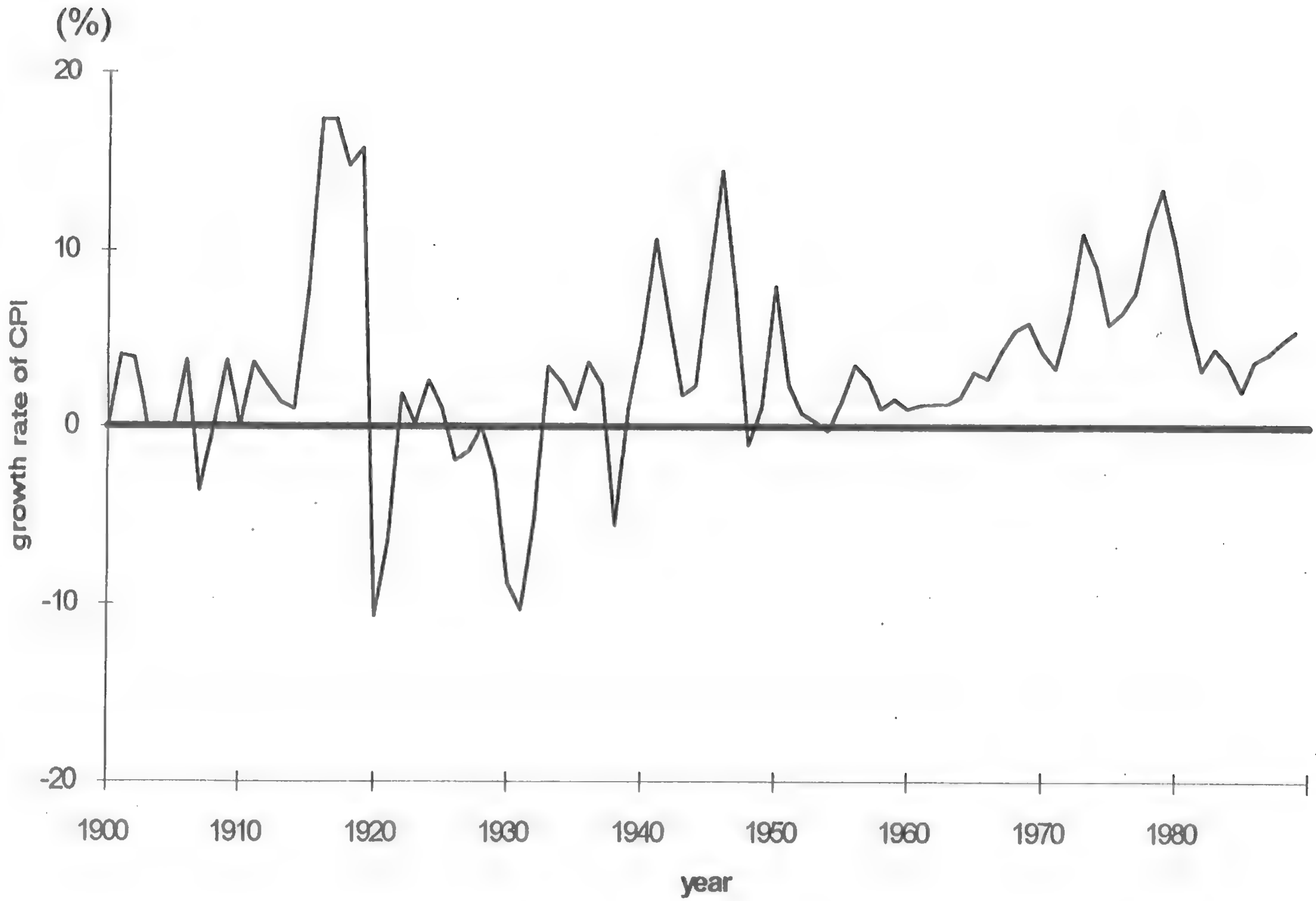

Figure II.6 Inflation Rate: Growth Rate of CPI

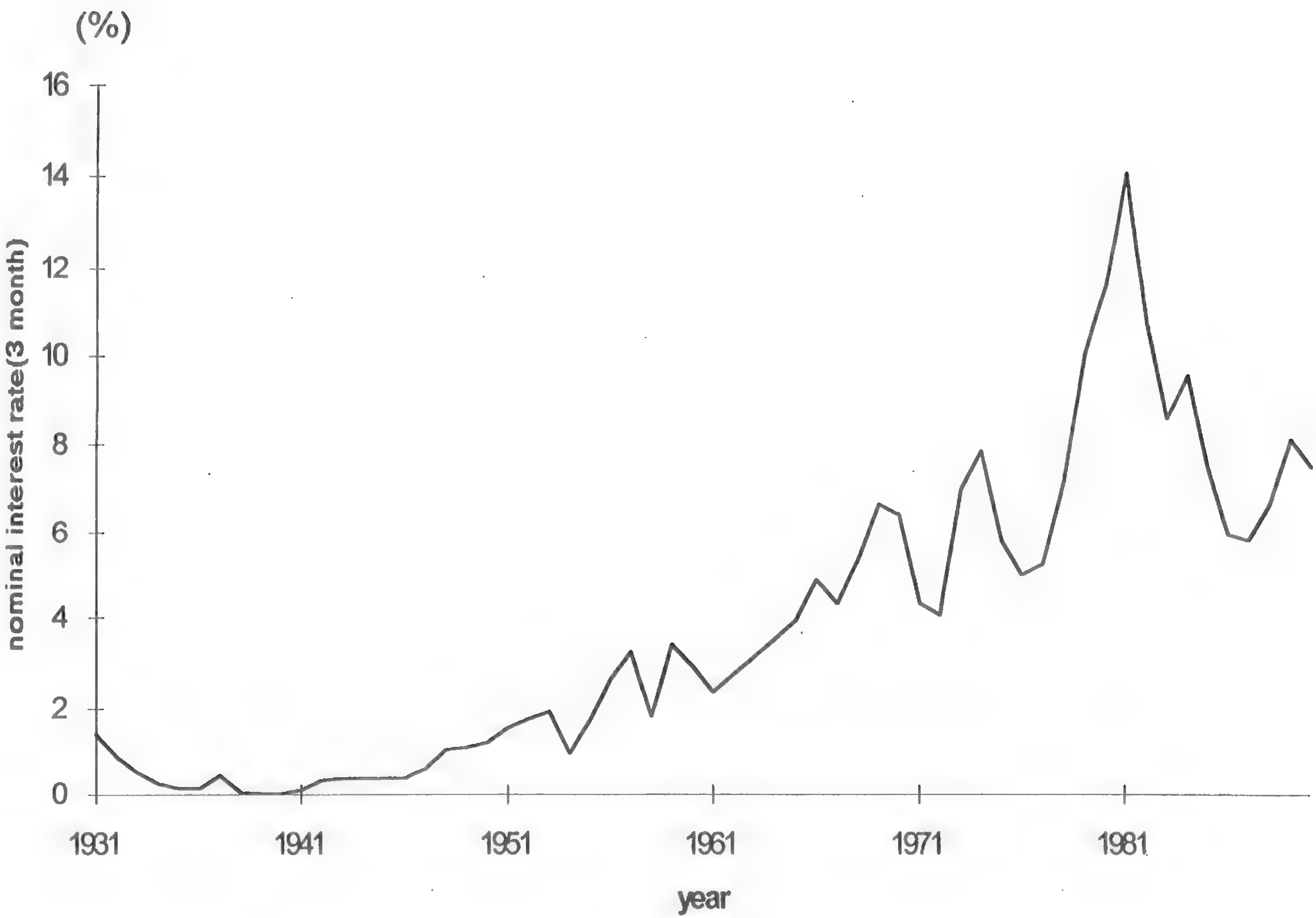

Figure II.7 Nominal Interest Rate(3 month)

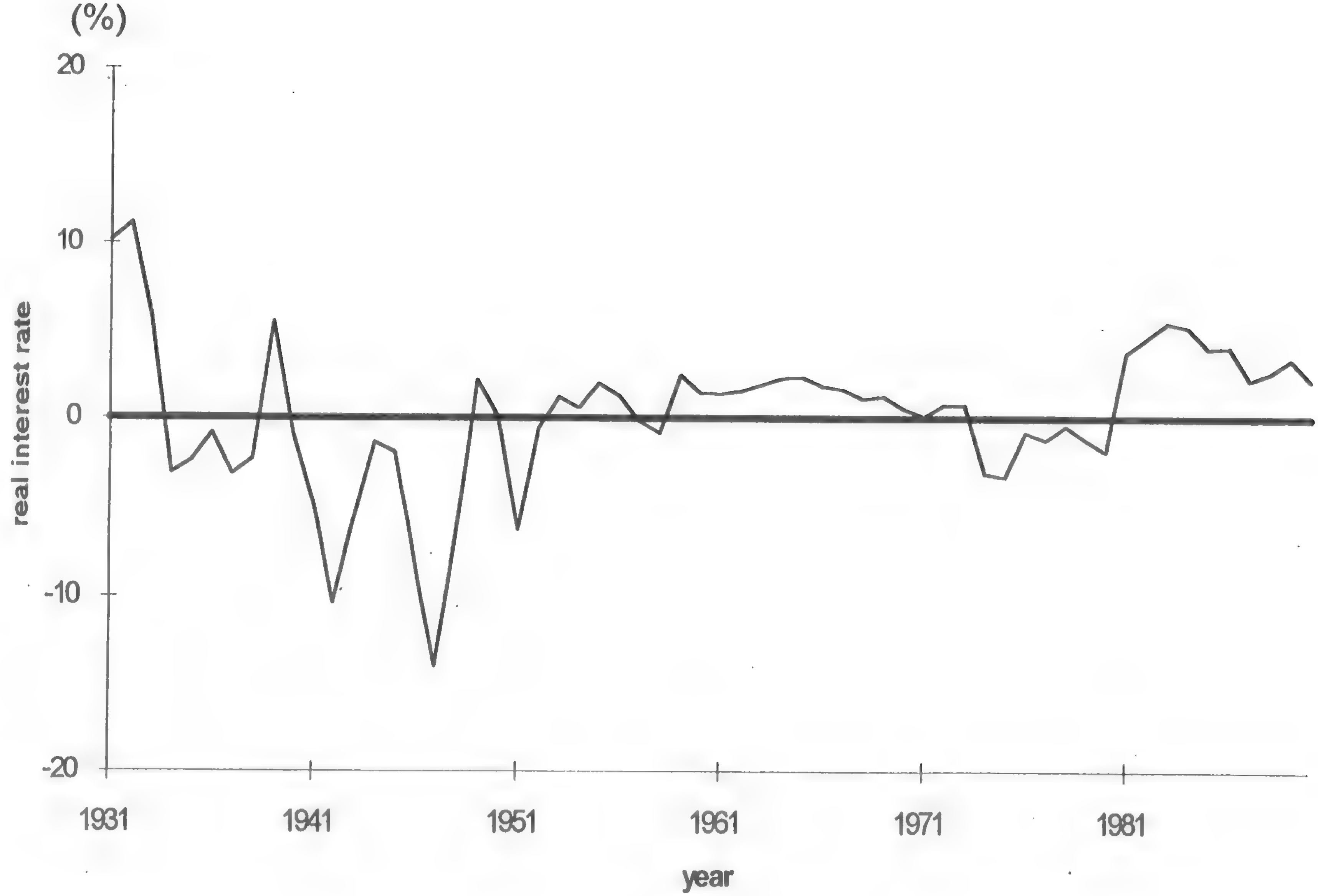

Figure II.8 Real Interest Rate

Appendix

DESCRIBING DATA USING STATISTICS

Economists assume that there is a random component to the underlying model generating our data. For instance, as Chapter III will show, technological innovations can be an important determinant of changes in real GNP. But almost by definition, a technological innovation is random; we'd all like the innovation so if we could predict it we would try to make it happen sooner.

Once we admit that our sample data - real GNP, inflation rates, nominal interest rates, etc. - is generated with a random component, we need to have a statistical way to describe them. This appendix provides some very simple definitions of important descriptive statistics. Before that, however, we will define a growth rate; growth rates are important because they measure movements over time. Since our economy is changing over time, and we need a simple way to describe its dynamic path.

Definition. A *growth rate* is the percentage change in a variable over time. That is, for any variable x_t, its growth rate is given by:

$$\frac{x_t - x_{t-1}}{x_{t-1}}$$

Now we move on to some simple descriptive statistics. Since we work with a finite sample of data, each of these statistics are imprecise estimates of the true mean and variance of the data.

Definition. The *sample mean* of a variable is an estimate of its average value over the sample in question. The sample mean of a variable x_t, where $t=1,2,3,\ldots,T$, is denoted $\overline{x}$ and is given by:

$$\overline{x} = \frac{1}{T}\sum_{t=1}^{T} x_t$$

where $\sum_{t=1}^{T}$ denotes the sum from $t=1$ to T (ie. $x_1+x_2+x_3+\ldots+x_T$).

Definition. The *sample variance* of a variable is an estimate of its spread or variability over the sample in question. The sample variance of a variable x_t is given by:

$$\frac{1}{T-1}\sum_{t=1}^{T}(x_t - \bar{x})^2$$

Definition. The *sample correlation coefficient* between two variables is an estimate of the linear relation between them. The sample correlation coefficient between variables x_t and z_t is given by:

$$\rho_{xz} = \frac{\sum_{t=1}^{T}(x_t-\bar{x})(z_t-\bar{z})}{\sqrt{\sum_{t=1}^{T}(x_t-\bar{x})^2\sum_{t=1}^{T}(z_t-\bar{z})^2}}$$

The sample correlation coefficient ranges between -1 and +1. If two variables tend to go up together and down together, they will have a positive correlation coefficient. If two variables go in opposite directions, they will have a negative correlation. If there is no systematic relation between two variables, the correlation coefficient will be zero. Keep in mind that correlation between two variables tells us nothing about *causation*. Just because x_t and z_t tend to move together as measured by a positive correlation coefficient, we don't know whether x_t causes the movement in z_t or z_t causes the movement in x_t.

Another way to address a linear relation between two or more variables is through regression analysis. Here I will focus on regression with only one "explanatory" variable called univariate regression. The case with more than one explanatory variable is called multiple regression.

Definition. The *sample regression coefficient* (denoted β) between the dependent variable z_t and the independent variable x_t in the linear regression

$$z_t = \alpha + \beta x_t + \epsilon_t$$

is an estimate of the slope of the linear relation between the two variables. The sample regression coefficient is given by:

$$\beta = \frac{\sum_{t=1}^{T} (x_t - \bar{x})(z_t - \bar{z})}{\sum_{t=1}^{T} (x_t - \bar{x})^2}$$

so it is easy to see that the sample correlation coefficient and sample regression coefficient are closely related. There is a difference; we actually take a stand on causation from x_t to z_t in deriving this estimate of their linear dependence. If we are wrong the estimate may be biased.

Since the calculated β is only an estimate of the true linear relation, we can test whether the calculated β is "significantly different" from the hypothesized true beta (I'll denote it β^{true}. One particularly important test is where there is no relation between z_t and x_t (ie. that in truth there is zero relation or $\beta^{true}=0$). Here we use a t-test. The t-test is given by:

$$t_{T-2} = \frac{\beta - \beta^{true}}{s_\beta}$$

where s_β is the standard error of the estimate of β (ie. the imprecision in estimating β). This standard error is related to the variance of the estimate and is given by:

$$s_\beta = \frac{\left(\frac{\sum_{t=1}^{T} (z_t - \alpha - \beta x_t)^2}{T-2}\right)}{\sum_{t=1}^{T} (x_t - \bar{x})^2}$$

For large enough sample sizes ($T \approx 100$ observations), if the calculated t_{T-2} is greater than the absolute value of 2, we can fairly confidently reject that the estimated β is equal to the hypothesized β^{true}. Essentially, this just says that since the estimate is farther than 2 standard errors away from what is hypothesized to be true, we can be confident that the estimate is not β^{true}.

A good regression equation is one that helps explain a large proportion of the variance of the dependent variable, in this case denoted z_t. By definition, the total variation (TV) in z_t can be broken up into the explained variation (EV) and the unexplained variation (UV). That is, TV = EV + UV. Dividing through by TV, we have 1 = EV/TV + UV/TV. But recall, I started the paragraph saying a good regression equation is one that helps explain a large proportion of the variance of the dependent variable. The explained part as a proportion of the

total variance of the dependent variable is just EV/TV. A descriptive statistic of "goodness of fit" is called R-squared and is given by:

$$R^2 = \frac{EV}{TV} = 1 - \frac{UV}{TV} = 1 - \frac{\sum_{t=1}^{T} \epsilon_t^2}{\sum_{t=1}^{T} (z_t - \bar{z})^2}.$$

R-squared lies between 0 and 1. A perfect fit would be where the sum of squared prediction errors are zero (ie. $\sum_{t=1}^{T} \varepsilon_t^2 = 0$) or $R^2 = 1$.

Chapter III

A SIMPLE MODEL OF THE DETERMINATION OF OUTPUT

In this chapter we want to provide the simplest possible environment to study the determination of real GNP. We will focus on an individual who is self-employed and consumes the fruits of her labor. There are early examples of such individuals; Yeoman Farmers after the breakdown of the medieval system of serfdom in England. A good example from literature of the type of individual we're going to model is Robinson Crusoe, who lives on a deserted island and must gather all his own food.

This simple environment will highlight the importance of:

(a) Technology and Production Possibilities
(b) Tastes or Preferences
(c) Optimizing Behavior

for the determination of real GNP.

A. PRODUCTION POSSIBILITIES

Let $n_t \equiv$ quantity of labor supply (measured in hours) in a given time period t.
$y_t \equiv$ quantity of output (measured in physical goods) in period t.

Then y_t/n_t measures productivity in period t.

$y_t = \theta_t f(n_t) \equiv$ output is related to labor hours input via a production function f( ) and state of technology θ_t in a given period. See Figure III.1.

As drawn, this production function exhibits law of diminishing returns. This reflects the fact that as you add more and more labor hours to a given machine each hour is less productive; workers start to get in each others way.

Let the marginal product of labor (MPL) $= \Delta y_t/\Delta n_t \equiv$ incremental change in output as we add 1 labor hour in a given period (Note Δ denotes change. In this case, it refers to a change in labor hours in a given time period, not across time periods). See Figure III.2.

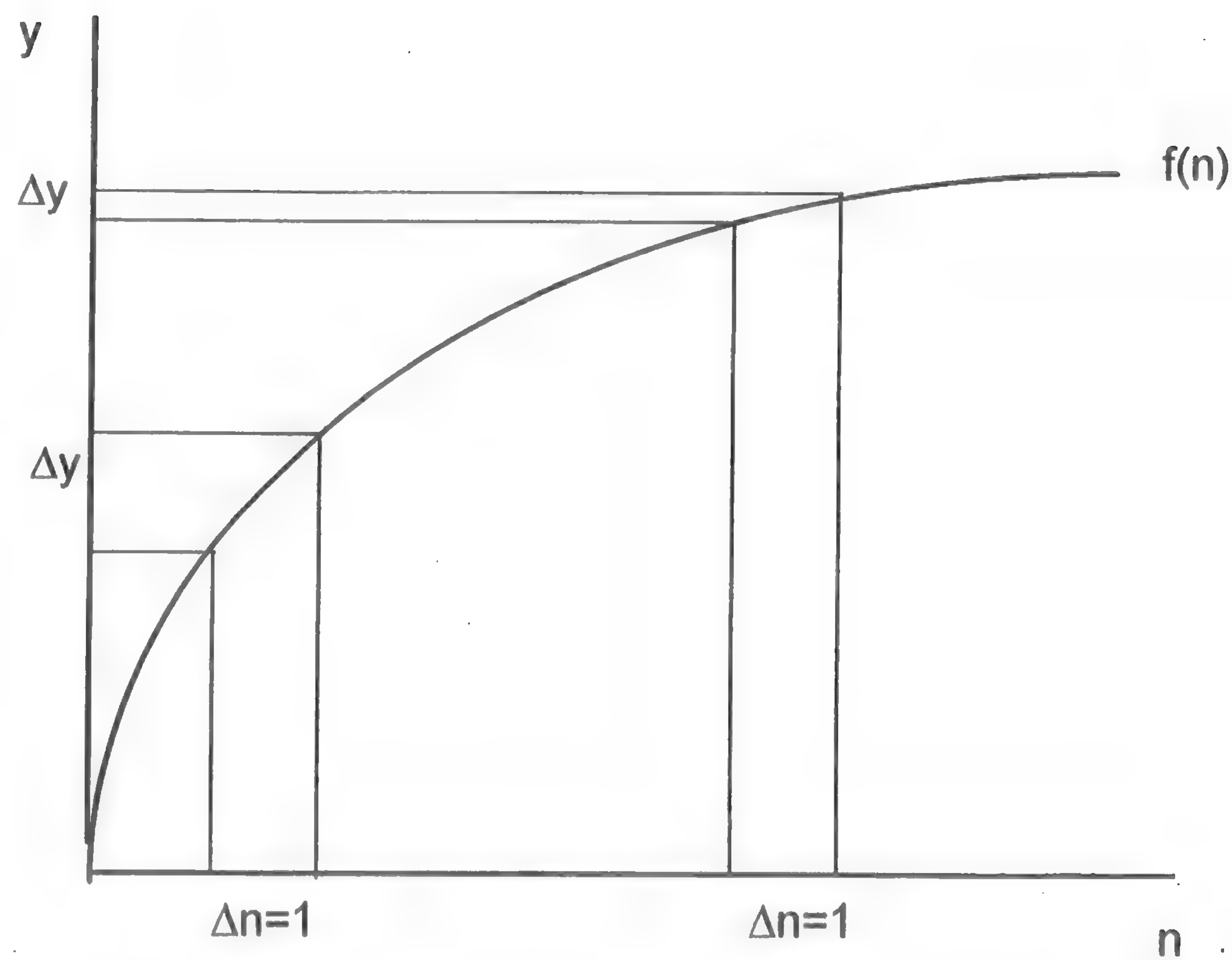

Figure III.1 Production Function

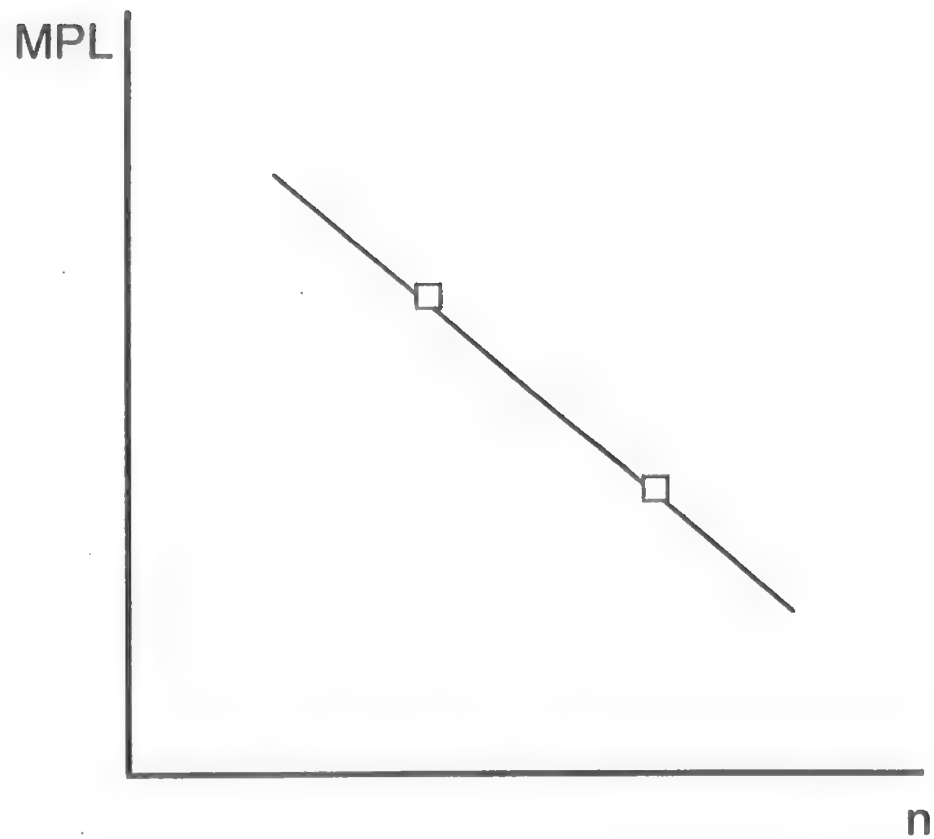

Figure III.2 MPL and n

Effects of Technological Change. See Figure III.3.

B. PREFERENCES FOR CONSUMPTION & LEISURE

We want a way to express people's happiness they derive from consumption and leisure (their displeasure with work).

Let $U(\overset{+}{c_t},\overset{-}{n_t})$ denote the utility derived from consuming c_t units of goods and the disutility derived from working n_t hours in a given time period t. Utility is increasing in consumption (I like to eat) and decreasing in labor hours (I don't like to work).

Definition An *indifference curve* is the set of points of combinations of c_t and n_t that provides the agent with identical levels of utility. See Figure III.4.

Let the marginal rate of substitution (MRS) = $\Delta c_t/\Delta n_t \equiv$ rate at which I substitute consumption and leisure. The MRS is just the slope of an indifference curve.

C. OPTIMIZATION AND EQUILIBRIUM

Simply put, Robinson Crusoe wants to choose a bundle of consumption and leisure to achieve the most happiness given his technological possibilities.

We write this formally as:

$$\text{Choose } c_t, n_t \text{ to Max } U(c_t, n_t)$$

$$\text{s.t. } c_t = y_t = \theta_t f(n_t)$$

It's easy to see this graphically in Figure III.5.

We've just determined equilibrium output (eg. real GNP), employment hours per worker) (e.g. productivity), and real consumption!

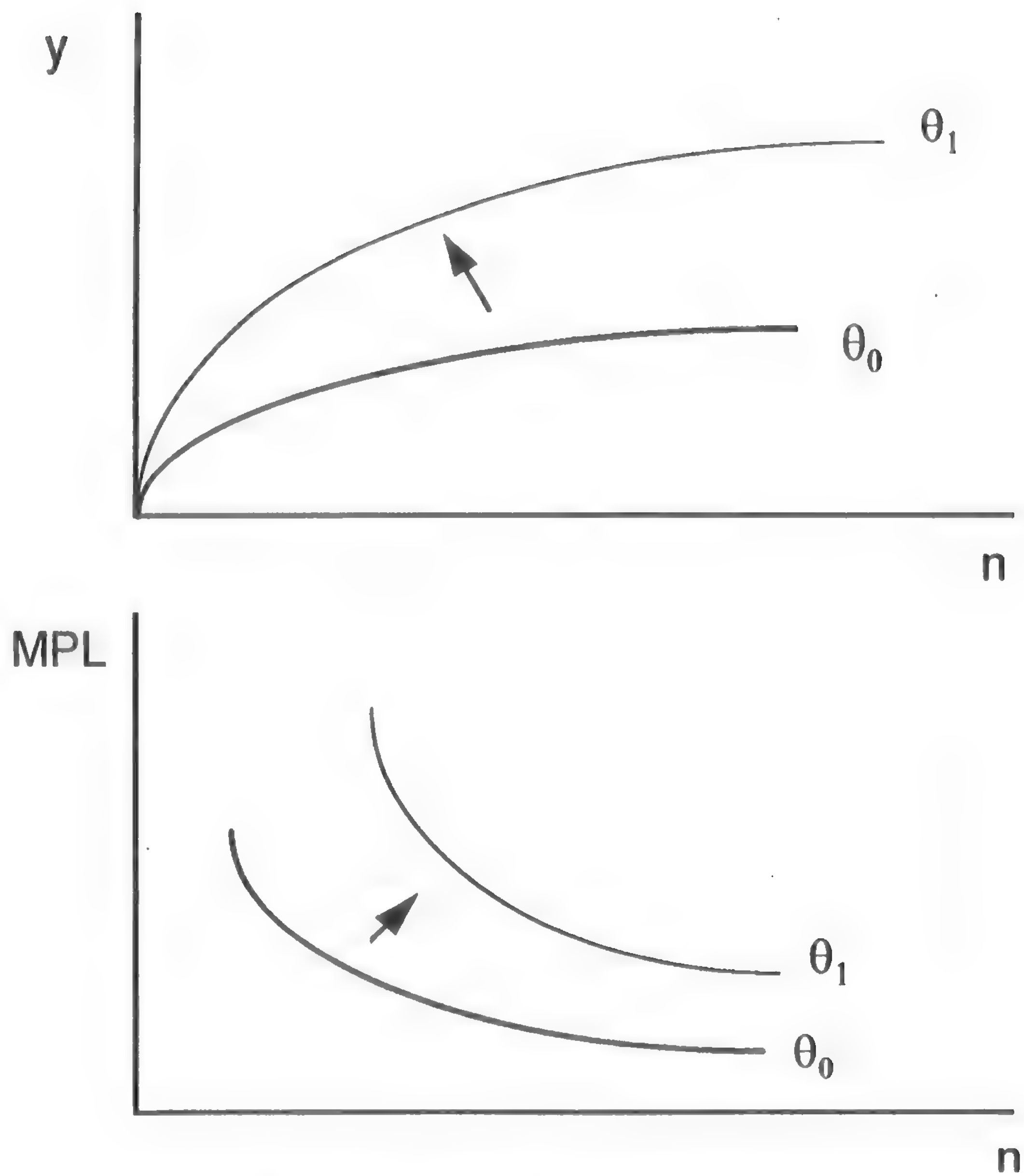

Figure III.3 Effects of Technological Change

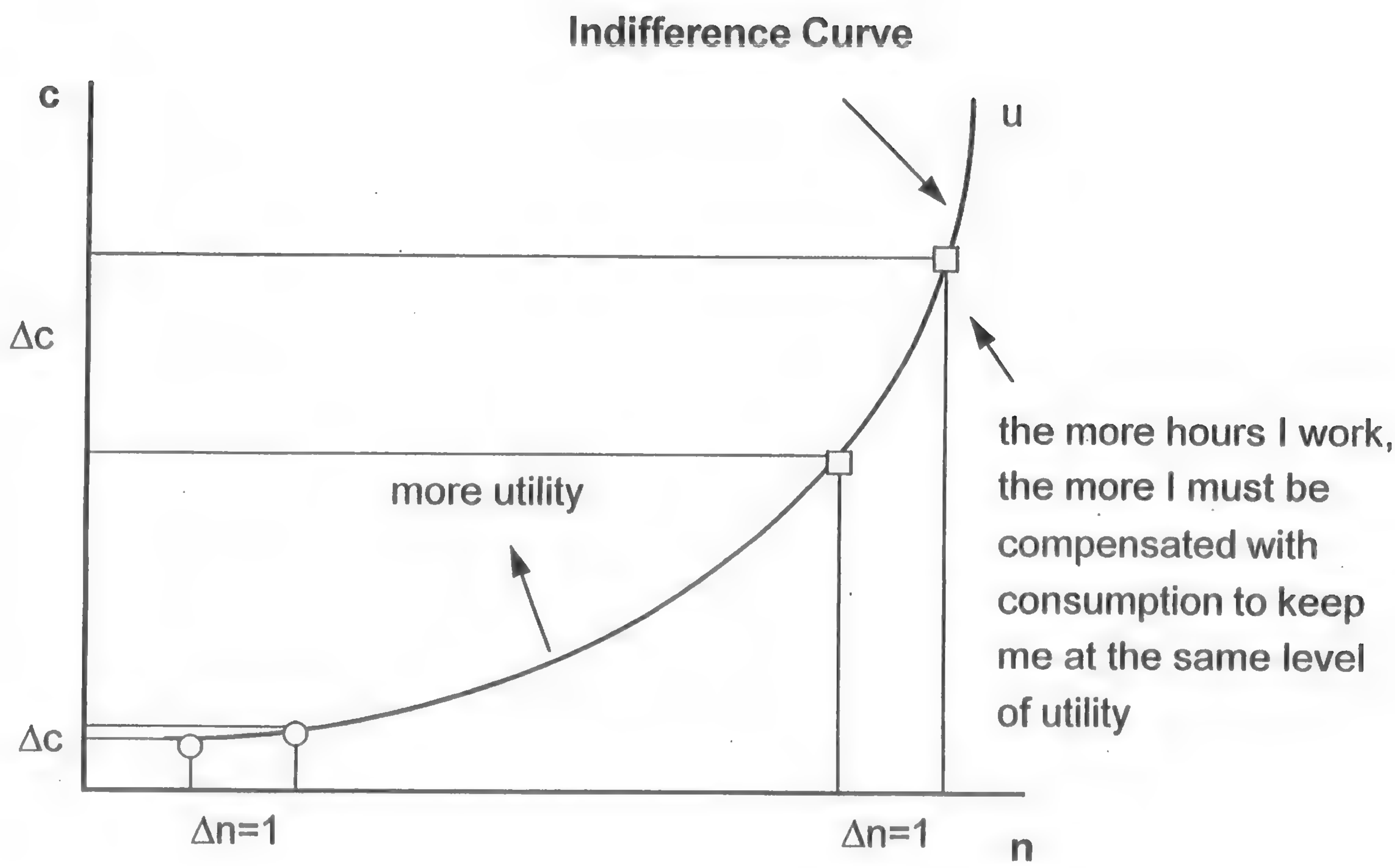

Figure III.4 Preferences for Consumption and Leisure

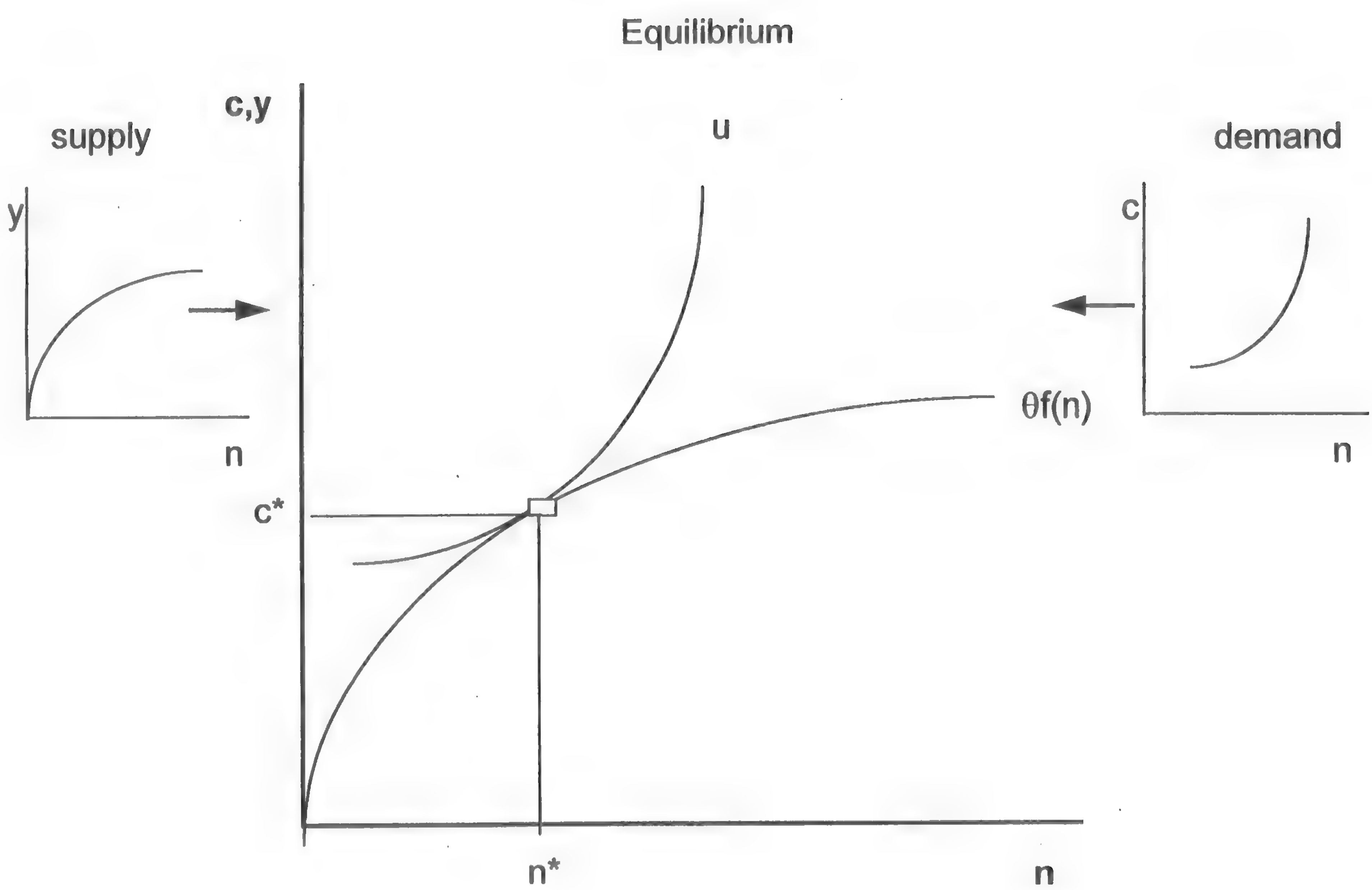

Figure III.5 Equilibrium

D. ON INCOME AND SUBSTITUTION EFFECTS OF TECHNOLOGICAL CHANGE

Supressing time subscripts, what is the impact of a technology shock (a rise in θ) on hours (n^*), real GNP (y^*), and real consumption (c^*)? See Figure III.6.

A rise in θ_0 to θ_1 has the following effects:

(a) $n_1^* > n_0^*$ (i.e. an increase in hrs)

(b) $y_1^* > y_0^*$ (i.e. an increase in real output)

(c) $c_1^* > c_0^*$ (i.e. an increase in real consumption)

(d) $\dfrac{y_1^*}{n_1^*} > \dfrac{y_0^*}{n_0^*}$ (i.e. an increase in productivity)

(e) $\dfrac{y_1^*}{n_1^*} < y_1^*$ (i.e. productivity doesn't increase as much as real output)

How does this predication match with the data? See Figure III.7 where real GNP growth and growth and growth in average product of labor (y/n) is graphed.

Is it clear that a technology shock should increase hours? The Answer depends on how much Rob desires leisure as his output rises.

Economists answer this question by disentangling income & substitution effects.

As the MPL rises in response to the technology shock, agents substitute out of leisure and into consumption. See Figure III.8 (i.e. $c_s > c_0^*$, $n_s > n_0^*$ (i.e. leisure falls) This is known as the *substitution* effect.

As the agent's income rises, holding fixed the MPL schedule, an agent chooses more consumption and leisure. (i.e. $c_1^* > c_s^*$, $n_1^* < n_0^*$ (i.e. leisure rises). This is known as the *income* effect.

So if substitution effects dominate income effects, hours rise.

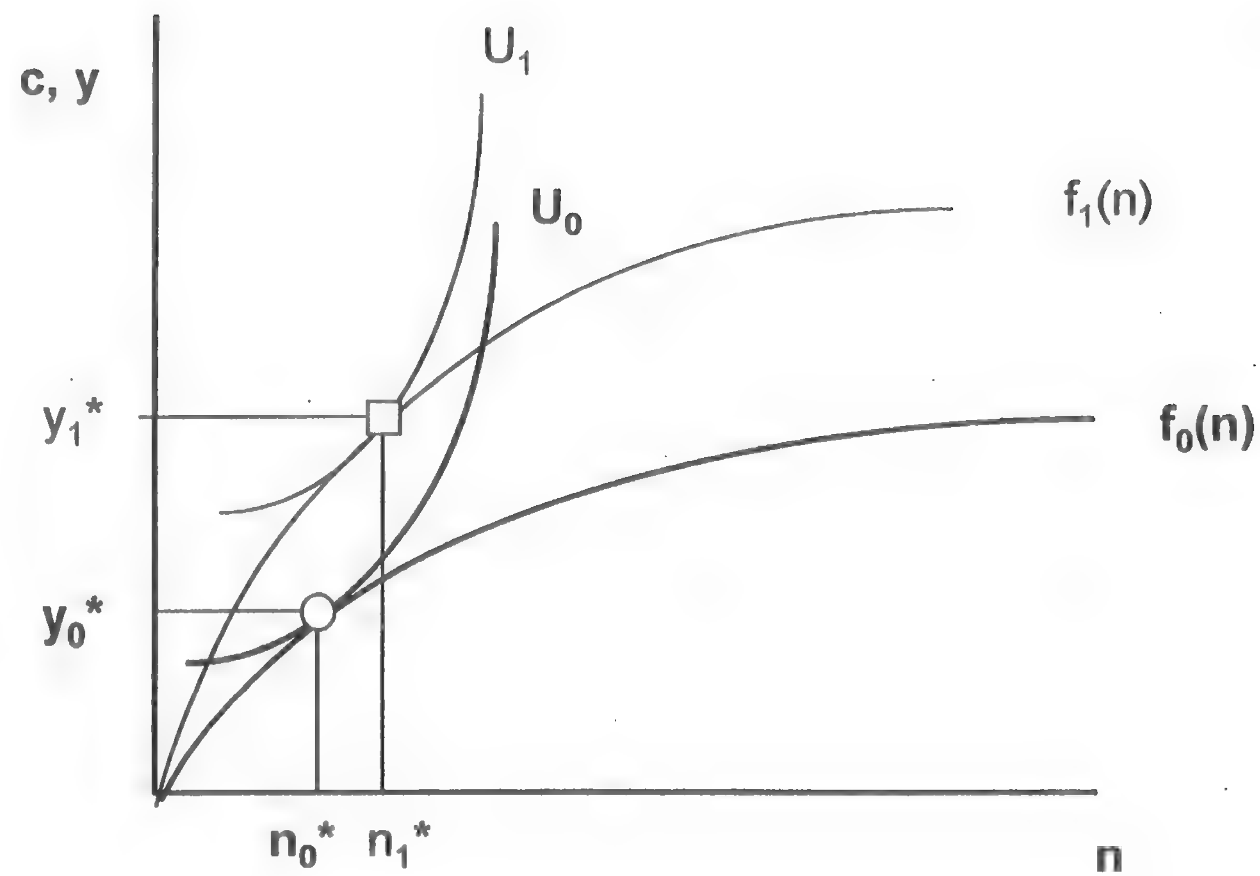

Figure III.6 The Impact of a Technology Shock

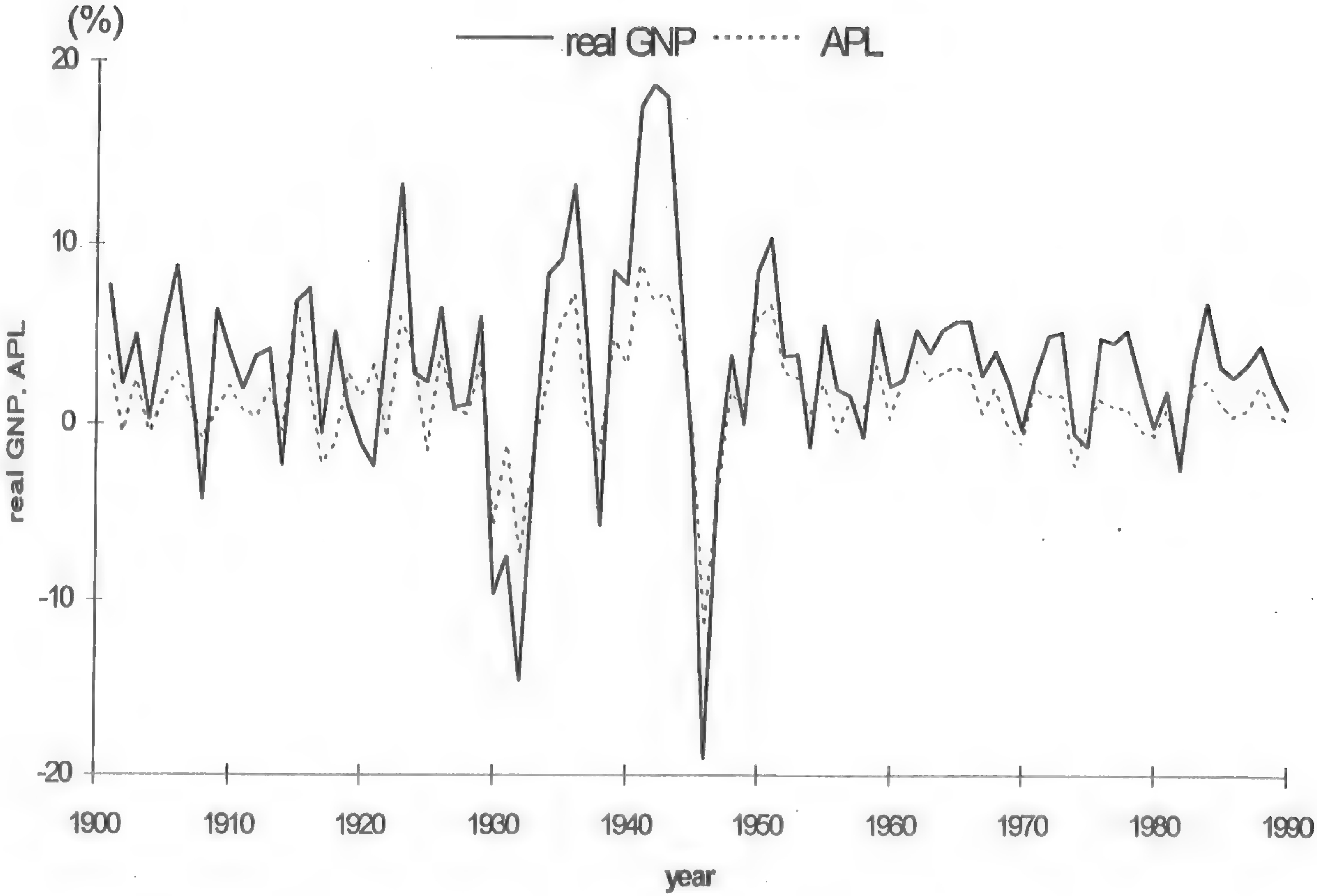

Figure III.7 Growth Rate of Real GNP and APL

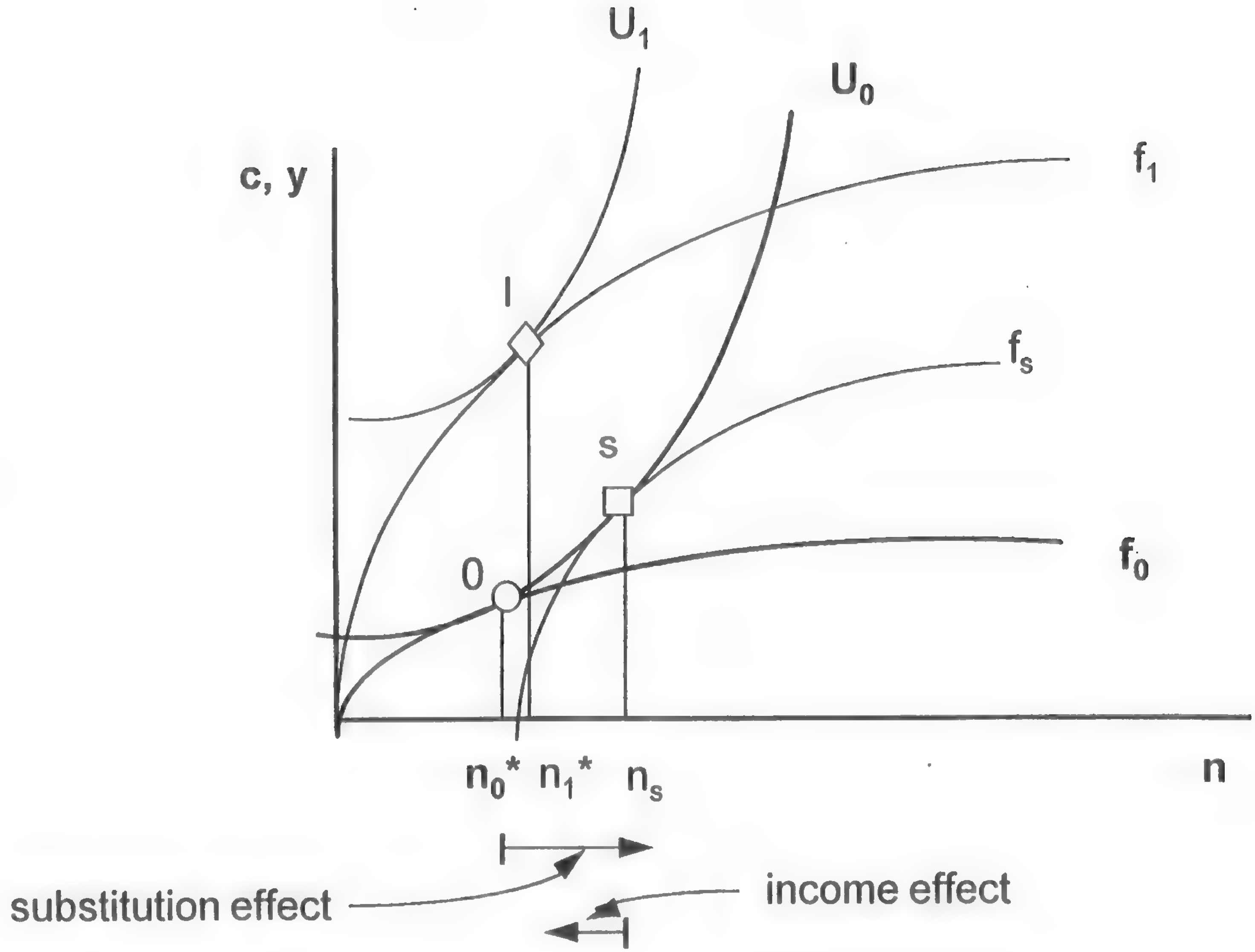

Figure III.8 Substitution > Income Effects

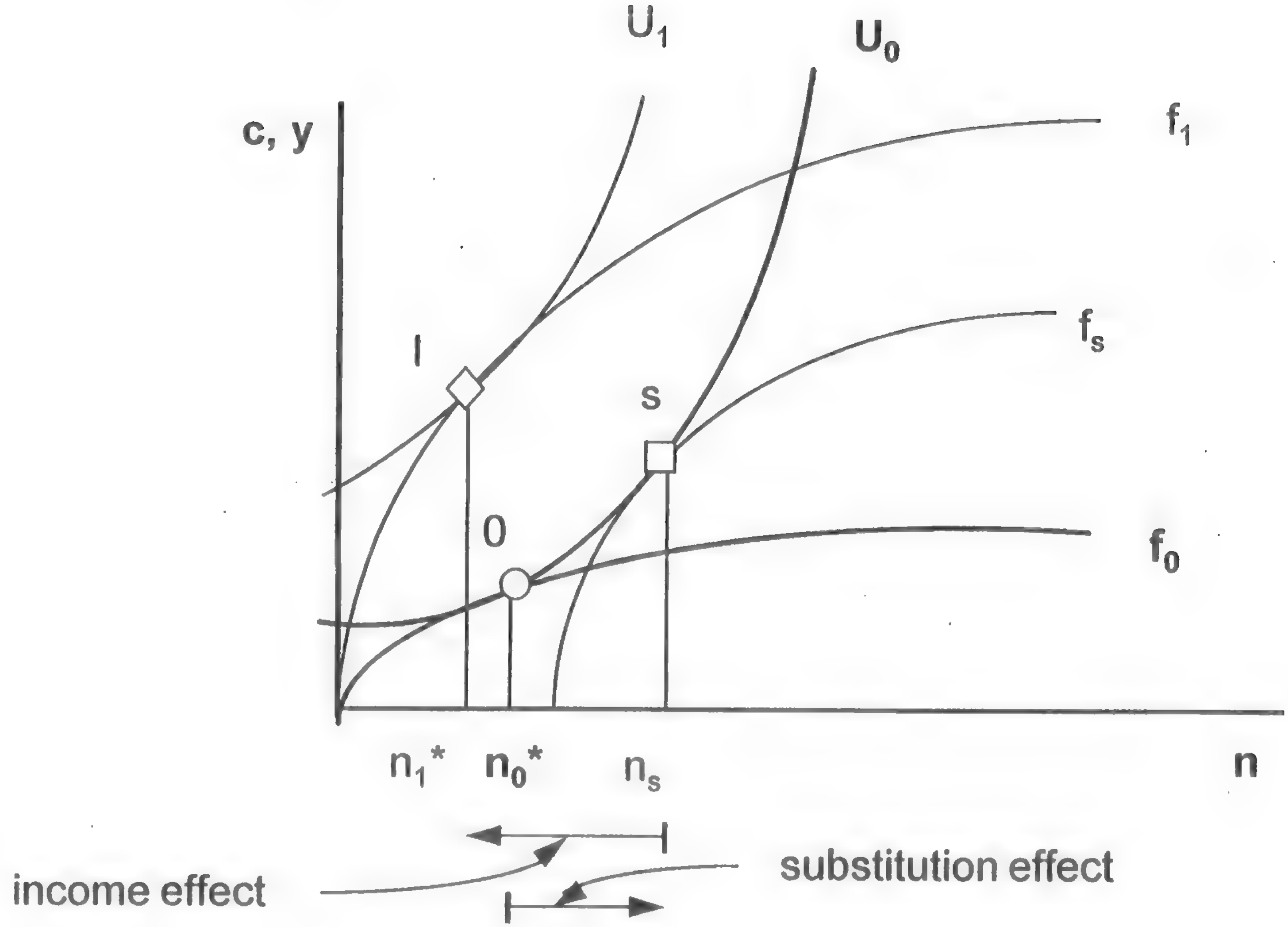

Figure III.9 Income > Substitution Effects

Now consider the case where income effects dominate substitution effects. See Figure III.9.

In this case hours fall. This theoretical possibility is inconsistent with the *aggregate* data, as we've seen.[3] Therefore, typically we will assume substitution effects outweigh income effects.

E. THE MEASUREMENT OF TECHNOLOGICAL CHANGE

How do we actually measure technological change? Imagine how hard it would be to survey businesses about their research and development? About their innovations on the assembly line?

Nobel prize winner Robert Solow proposed a method to "back out" from the data a measure of technological change. Since it is intimately related to production, we begin with the production function. In this section, we will add an additional input x_t into the production function (this proxies capital, which will not be studied until Chapter X but is essential to the technique for measuring technological change). We will also take a special functional form (called Cobb-Douglass) for the production function. Specifically, let

$$y_t = \theta_t f(n_t, x_t) = \theta_t n_t^{\alpha} x_t^{1-\alpha}$$

where $0<\alpha<1$ and measures the labor's share of output while $(1-\alpha)$ measures the other input's share of output. You should convince yourself that this functional form exhibits decreasing returns to scale by setting $x_t=1$ and plotting y_t against n_t for a given α (say ½). The plot should look like Figure III.1.

[3]There is some questionable evidence from micro data that hours fall for males at high wages. See J. Pencavel, "Labor Supply of Men: A Survey", Handbook of Labor Economics.

But then the percentage change in output over time is given by[4]:

$$\frac{\Delta y_t}{y_t} = \frac{\Delta \theta_t}{\theta_t} + \alpha \frac{\Delta n_t}{n_t} + (1-\alpha)\frac{\Delta x_t}{x_t}$$

That is, growth in technology, labor hours, and other factors all contribute to growth in real output. Now we have observable data on real GNP growth ($\Delta y_t/y_t$) and growth in labor hours ($\Delta n_t/n_t$), and suppose we have observable data on growth in the input x_t. Furthermore, we have data on labor's share of output (α has averaged a little over .7 since 1945). However, we don't have observable data on growth in technology ($\Delta\theta_t/\theta_t$). But we can "back this" unobservable data out from the observables. That is,

$$\frac{\Delta \theta_t}{\theta_t} = \frac{\Delta y_t}{y_t} - \alpha \frac{\Delta n_t}{n_t} - (1-\alpha)\frac{\Delta x_t}{x_t}$$

What is left over (the residual) after we subtract out growth in labor hours and other inputs from GNP growth is just the contribution of technological change to output growth. We call what is left over the "Solow Residual". It is plotted in figure III.10 against real output growth. It is apparent from the figure that real output growth and Solow residuals (technological change) are positively correlated. If you don't understand my explanation, ask John in PBAB room W336 what his father did.

F. SUMMARY

When you look at the time series graph of the level of real output from 1900 to the present, you realize the importance of technology in determining both the level and fluctuations in real GNP.

We developed an extremely simple model to highlight the role of technological change in generating movements in GNP such as the expansions and contractions in the business cycle. Our simple model matched the data on procyclical hours (↑y, ↑n) and procyclical productivity (↑y, ↑y/n).

To match the procyclical hours we needed to assume substitution effects dominated income effects. This was probably the point at which you became confused (I promise this is probably the hardest part of the course, so if you master it now, you're set).

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[4]For those of you who know calculus, take the total differential of the production function and then divide both sides by y_t.

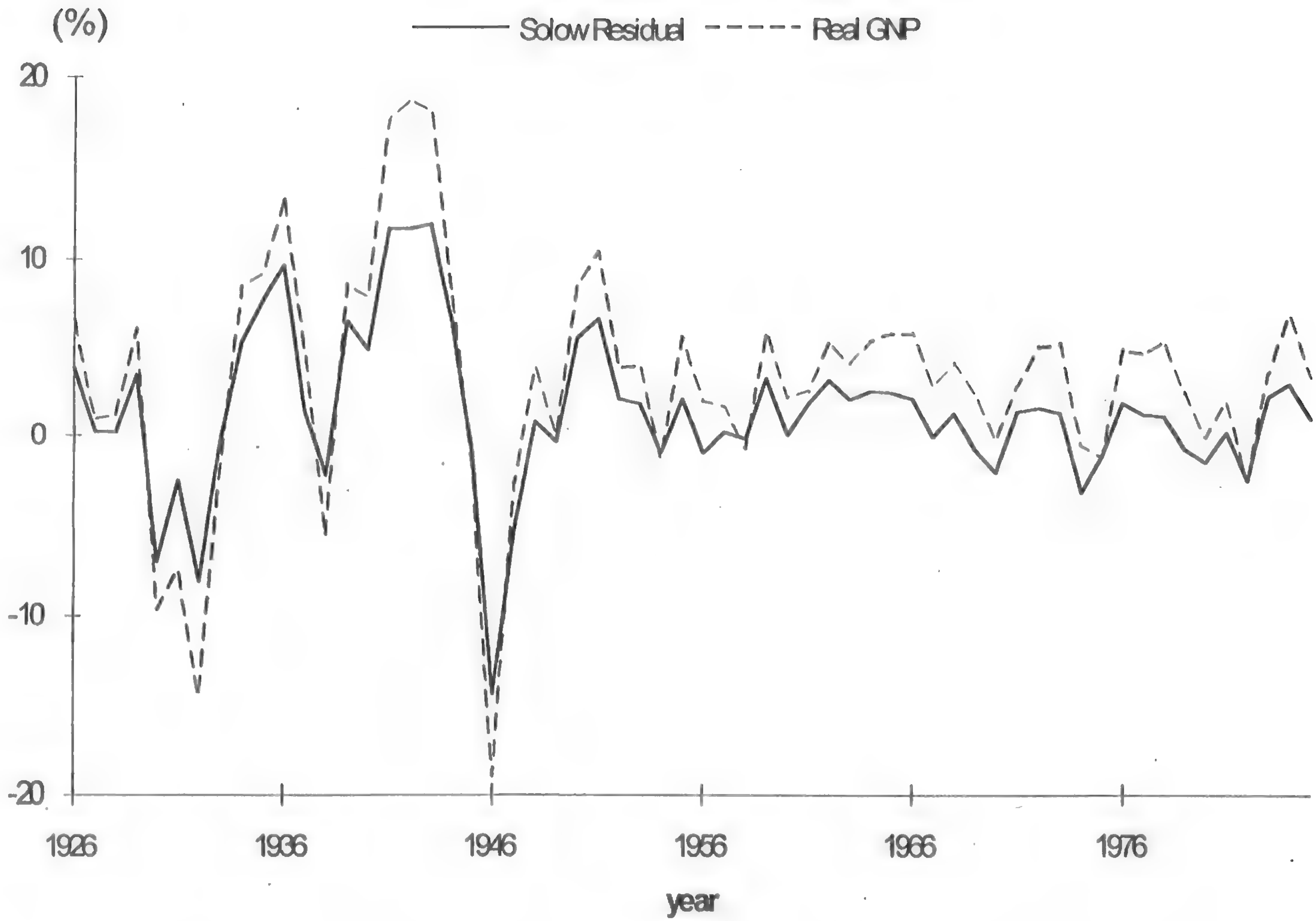


Figure III.10 Growth Rate of Solow Residual and Real GNP

Suppose I asked you, "If your real wage was to rise today, would you work more or less hours?" Some of you may say more. Some may say less. You may want to know what your existing real wage was. Each question reveals a complicated decision-making process that reflects your preferences.

What was the decision? Suppose you were happy at the going real wage. This meant that the marginal benefit (MB) of working more hours at the real wage (or the marginal product of your labor) = the marginal cost (MC) of working more hours (the disutility of labor). Now the real wage rises. This has two effects. Every existing hour (0 to n^*) you were working before now earns more real income. If you value leisure, you spend some of your new income on leisure, so labor hours fall.

At your old number of hours (n^*), it is now the case that the MB > MC. In that case you should work more hours. If the latter (substitution) effect dominates the former (income) effect, you work more hours, which is consistent with the data.

2D

Chapter IV

THE BOND MARKET

In this chapter we introduce the behavior that ultimately determines the most important (relative) price we will study this semester; the interest rate. To understand interest rates, we must study savings behavior.

In the last chapter, we saw that in response to a production shock and with no one else to trade, all output was consumed (i.e., $y_t = c_t$). But if we look at the data on non-durable consumption we see that consumption is smoother than real output. See Figure IV.1. In particular, while the variance of quarterly real GNP is 13.285, the variance of quarterly real consumption is lower at 4.007. Furthermore, while consumption is procyclical its correlation with output is only .56.

Thus, the simple model of Chapter III could not match the cyclical properties of consumption. That is, Chapter III predicts it is perfectly procyclical, which is not what we see in the data. What we haven't modelled yet is saving and dissaving, to which we now turn. See Figure IV.2. The difference between consumption and output in the aggregate data is made up of saving or dissaving. But since we haven't introduced storage or capital yet, what does it mean to save or dissave? In the aggregate data, household saving is used by firms to finance changes in their capital (i.e. investment) or by the government to finance its deficits.

For now we simply introduce a bond market. While it is still true that aggregate consumption = aggregate output (i.e. there's no aggregate savings), here we focus on individual decisions where it's possible that one agent saves (provided another borrows).

This chapter will highlight the importance of

(a) Asset markets for smoothing production or consumption across time.

(b) How agents' preferences for future consumption influence their behavior today (the important role of expectations).

(c) How changes in interest rates affect saving (dissaving).

To do this, we tell a simple story. Robinson Crusoe meets Friday. Rob, who is older and wiser, is highly productive today, but has low productive opportunities tomorrow (retirement). Friday, who is young and has a lot to learn today (i.e. is currently unproductive), has good prospects tomorrow. If both want smooth consumption, they can set up a bond

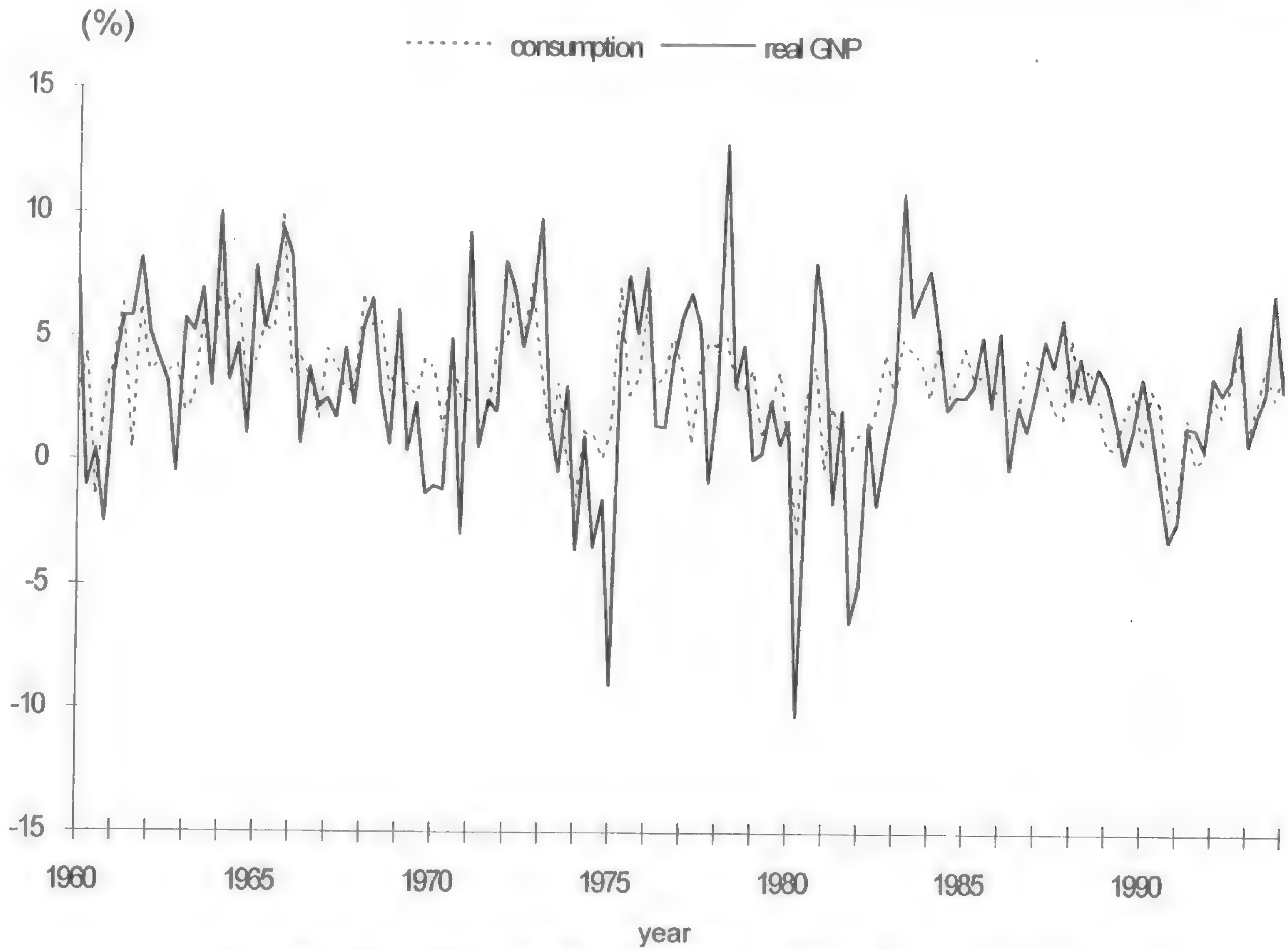


Figure IV.1 Growth Rate of Real GNP and Consumption

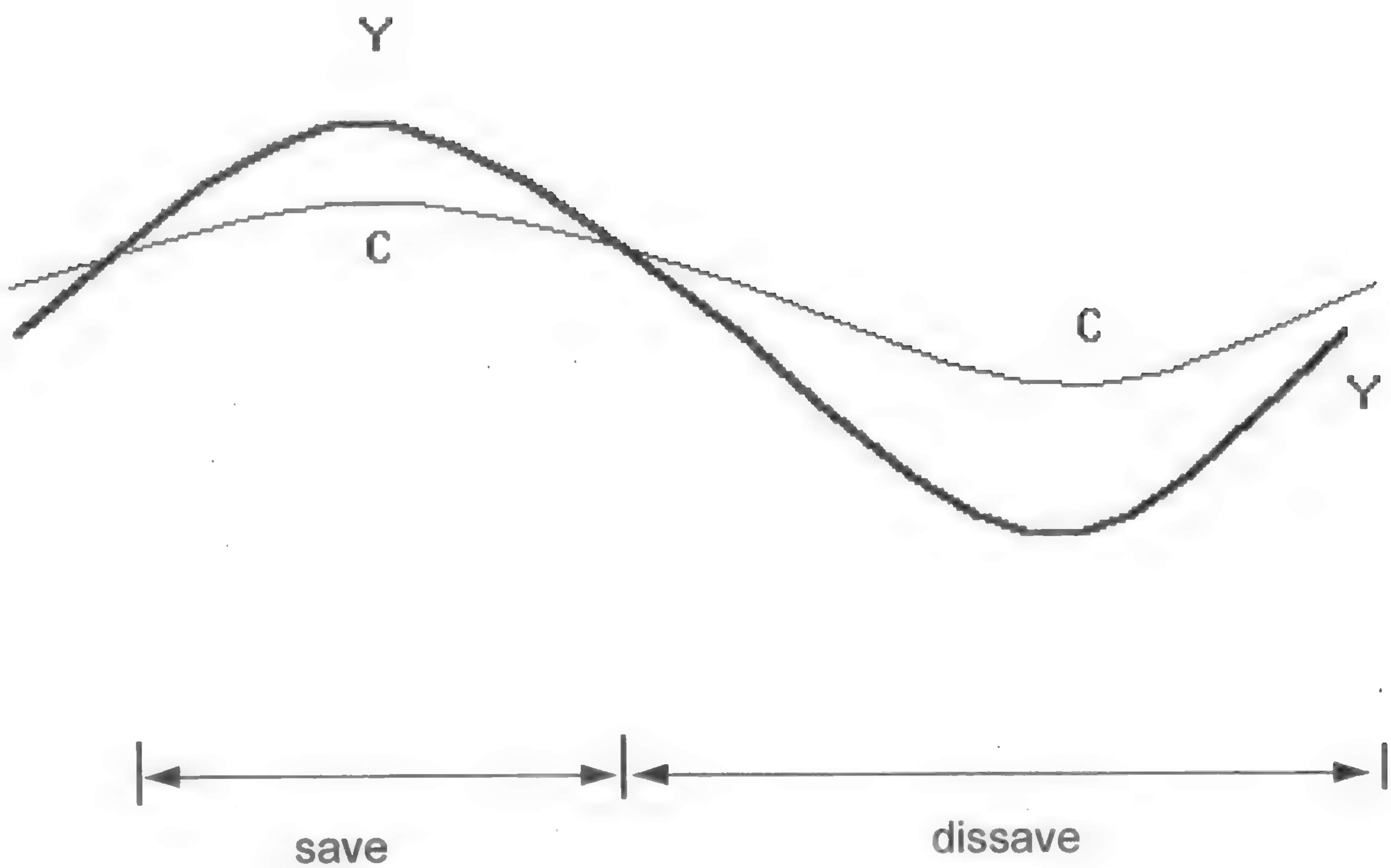


Figure IV.2 Saving and Dissaving

market. A bond is simply a promise by one agent to pay back a given amount of goods in the future in exchange for current goods.

A. THE INTERTEMPORAL POSSIBILITIES PROVIDED BY BONDS

Before, in any period t, an agent's consumption possibilities were limited by her production possibilities. (i.e. $c_t = y_t$). In this case, her *static budget constraint* is

A bond market expands her opportunities:

$$\text{(SBC)} \qquad \underbrace{c_t + b_t}_{\text{uses of funds}} = \underbrace{y_t + (1+r_{t-1})\, b_{t-1}}_{\text{sources of funds}}$$

where b_t denotes real bond holdings $b_t - b_{t-1} > 0$, implies the agent saves while $b_t - b_{t-1} < 0$, means she borrows and the real return on bonds held from t to t+1 is denoted r_t:

$\underline{t}$		$\underline{t+1}$
1 good	-------->	$(1+r_t)$ goods

Each period, the static budget constraints must hold.

$$\text{SBC}_t \qquad c_t + b_t = y_t + (1+r_{t-1})b_{t-1}$$

$$\text{SBC}_{t+1} \qquad c_{t+1} + b_{t+1} = y_{t+1} + (1+r_t)\, b_t$$

You should notice that b_t provides an intertemporal link between the static budget constraints in t and t+1.

Back to our story. Rob lives 2 periods t, t+1. He came into period t with no savings and obligations and he will die with no savings and obligations $\rightarrow (b_{t-1} = 0 = b_{t+1})$

Then we can re-write the sequence of SBC (just substitute b_t from SBC_{t+1} into SBC_t) as:

$$\text{(IBC)} \qquad c_t + \frac{c_{t+1}}{1+r_t} = y_t + \frac{y_{t+1}}{1+r_t}$$

This is known as the *intermporal budget constraint* (IBC). It just says the present discounted value (PDV) of expenditure must equal the PDV of income.

How do we see the intertemporal budget constraint graphically? See Figure IV.3

Rewrite (IBC) as:

$$c_{t+1} = \underset{\text{intercept}}{(1+r_t)y_t + y_{t+1}} - \underset{\text{slope}}{(1+r_t)}\, c_t$$

What if r_t rises? What if y_{t+1} rises? See Figure IV.4.

B. INTERTEMPORAL PREFERENCES

We want a way to express people's happiness from present and future consumption.

Let $U(\overset{+}{c}_t,\overset{-}{n}_t)$ denote utility derived from consuming c_t units of goods in period t and c_{t+1} units in period t+1. Utility is increasing in consumption (I like to eat) in both periods.

Definition An *indifference curve* is the set of combinations of c_t and c_{t+1} that provides the agent with identical levels of utility. See Figure IV.5.

Let the marginal rate of substitution (MRS) = $\Delta c_{t+1}/\Delta c_t \equiv$ rate at which I substitute consumption across time. The MRS is just the slope of an indifference curve in Figure IV.5.

(a) If I start with very little consumption today and lots tomorrow, to get one more unit today, I'd be willing to give up a lot of future consumption (MRS is high)

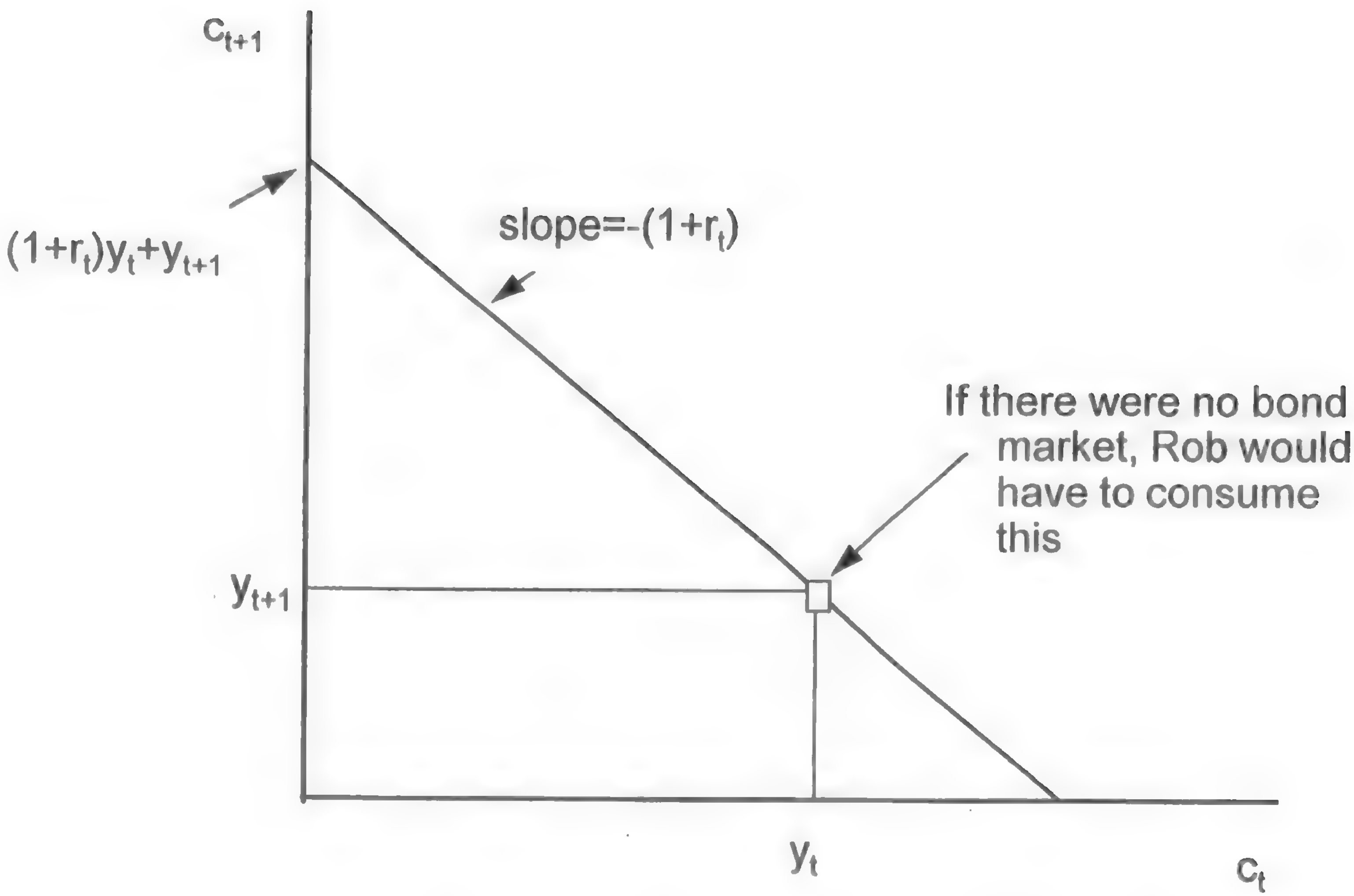


Figure IV.3 Intertemporal Budget Constraint

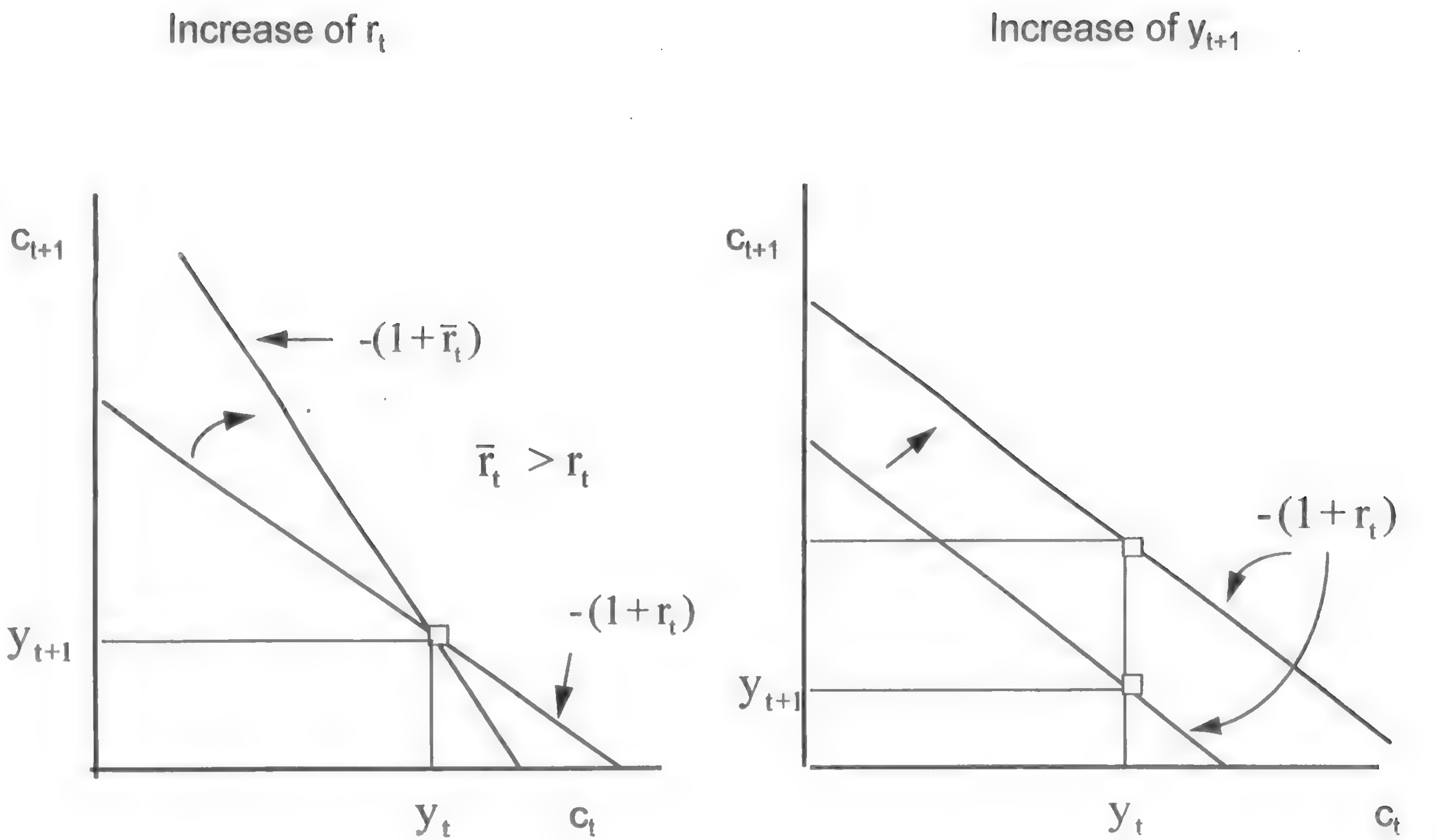


Figure IV.4 Changes of r_t and y_{t+1}

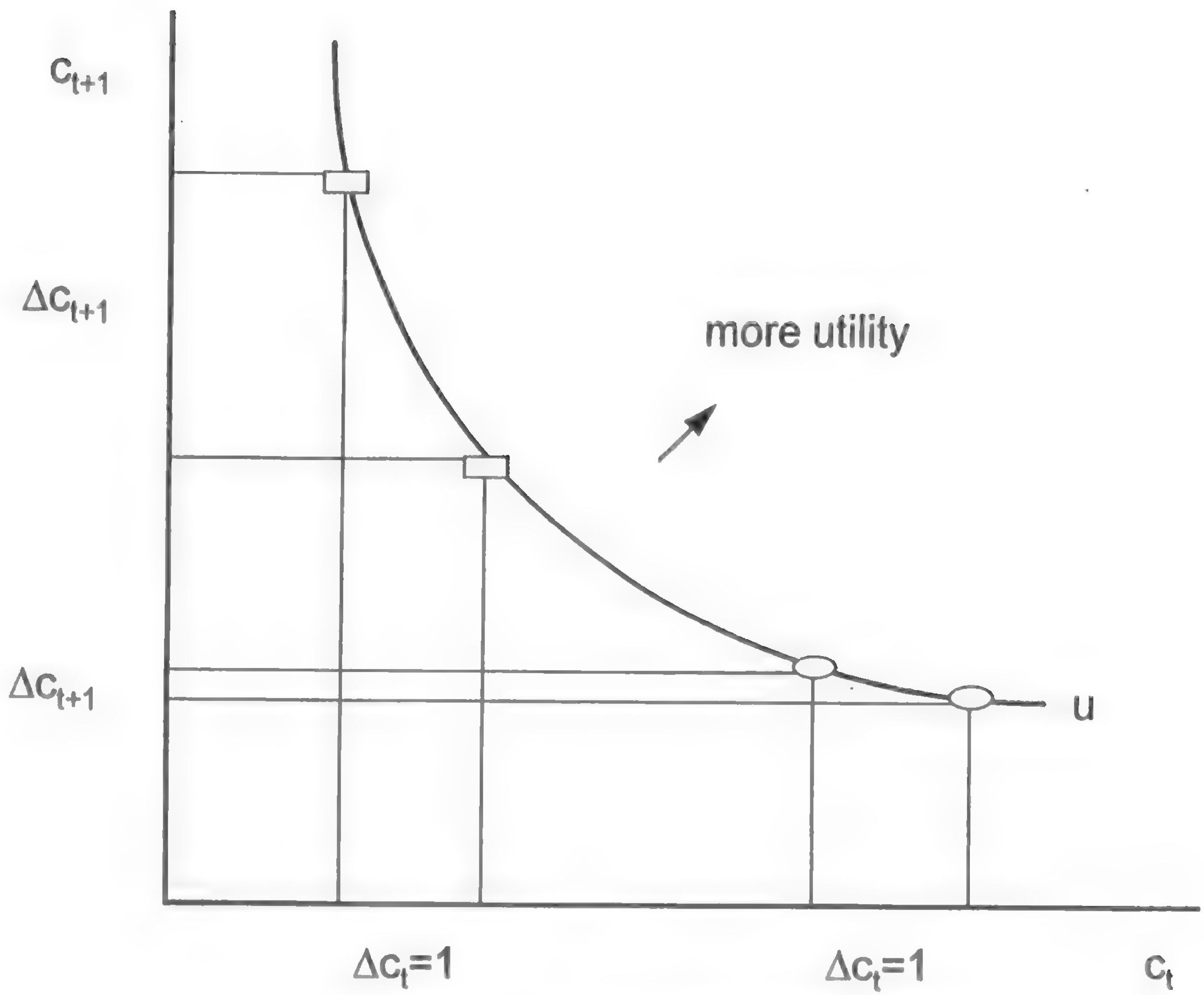


Figure IV.5 Indifference Curve

(b) The argument is exactly opposite if I start with a lot today and little tomorrow.

How do we characterize time preference? See Figure IV.6.

C. OPTIMIZATION

For the moment, neglect the labor supply decision.

Then the agent should choose c_t, c_{t+1} to

$$\max u(c_t, c_{t+1})$$

$$\text{s.t.} \quad c_t + \frac{c_{t+1}}{1+r_t} = y_t + \frac{y_{t+1}}{1+r_t}$$

As drawn, Rob saves by buying bonds (i.e., $b_t = y_t - c_t > 0$). See Figure IV.7.

D. INCOME AND SUBSTITUTION EFFECTS OF INTEREST RATE CHANGES

(a) What happens to current consumption (and bond holdings) if future income rises? This is a pure income effect. See Figure IV.8.

From a position where the agent was consuming all her income in each period (so $b_t^* = 0$), she borrows against her future income.

Note that expected changes in future income can change agents' consumption today.

(b) What happens to present consumption (and bond holdings) if interest rates rise? See Figure IV.9.

From a position where the agent was consuming all her income in each period (i.e. $b_t^* = 0$), she saves in the form of bonds.

Note: This was a special case because we started with $b_t^* = 0$. In general, if $b_t^* \neq 0$, there will be both income and substitution effects. For instance, to consider a rise in interest rates if the agent was a borrower, See Figure IV.10.

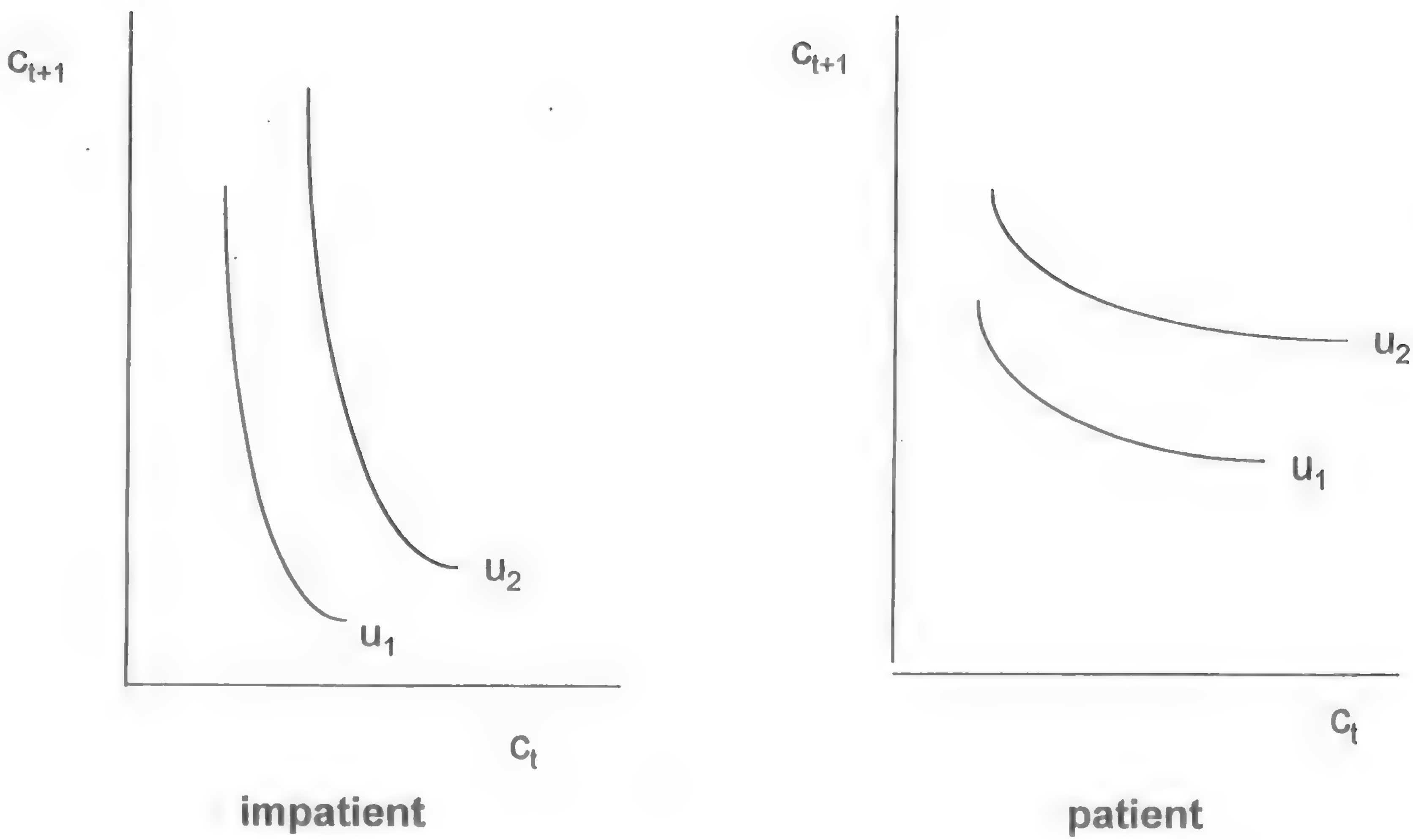


Figure IV.6 Characterization of Time Preference

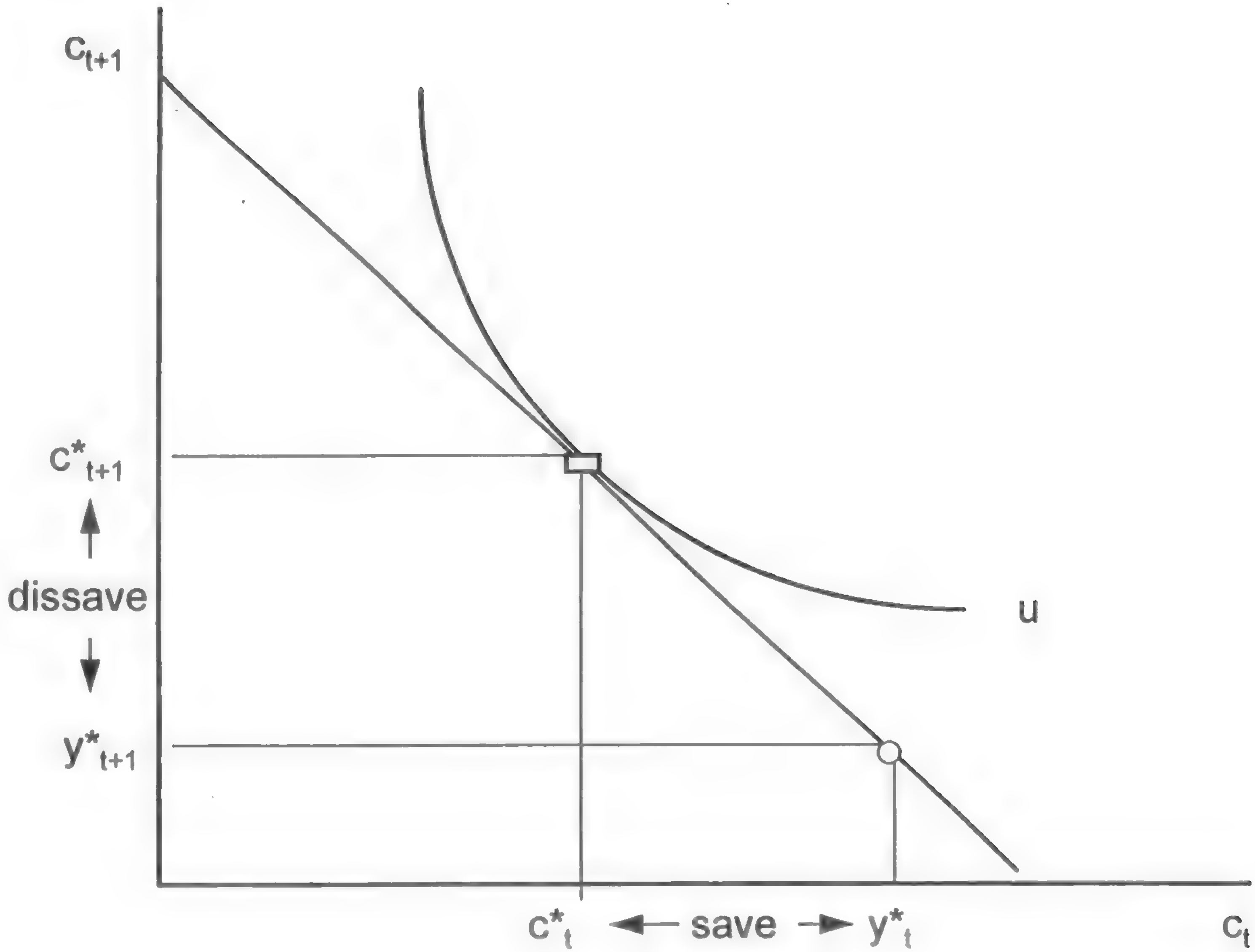
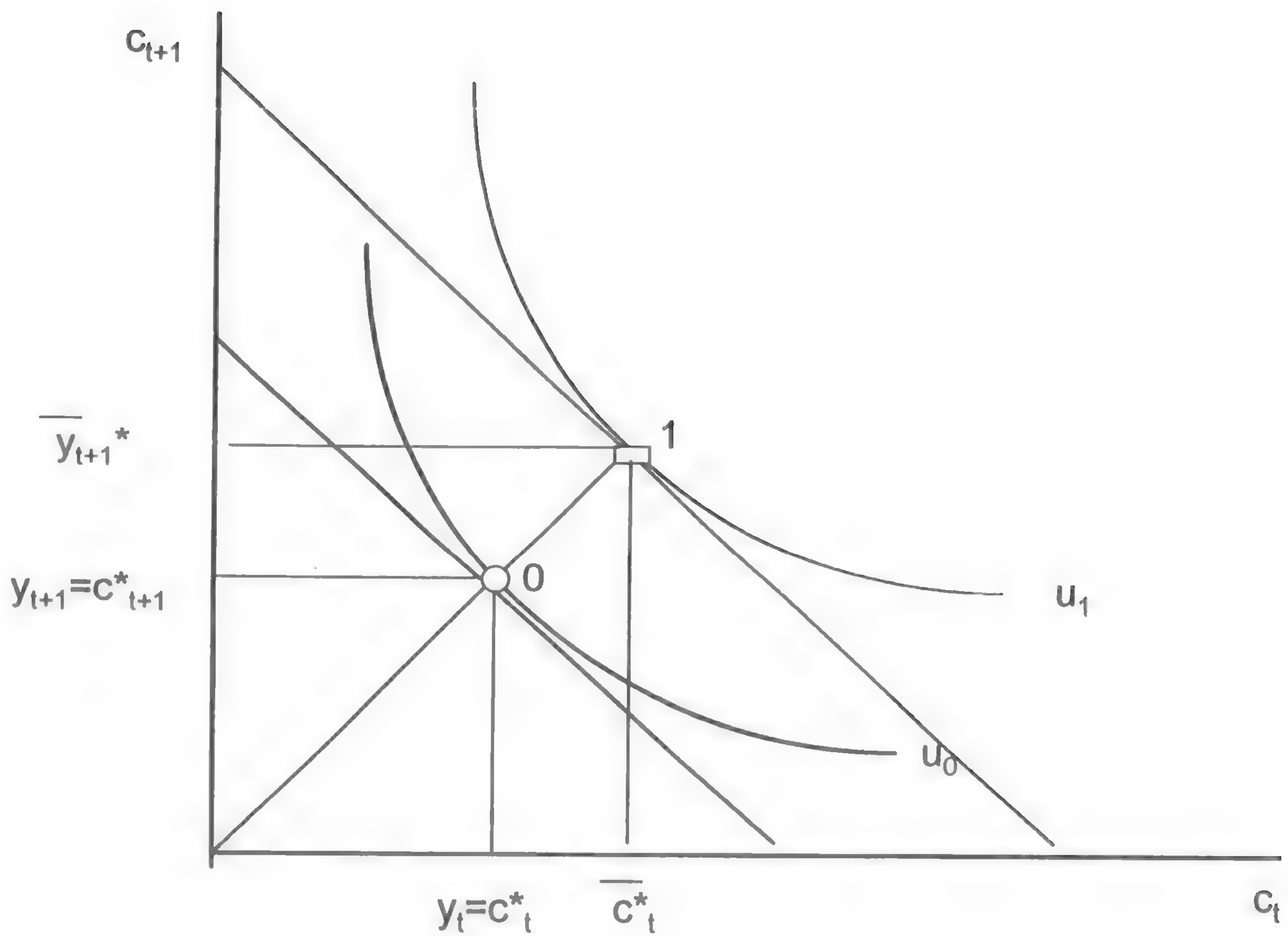


Figure IV.7 Optimization



$\overline{b^*_t} = yt - \overline{c^*_{t+1}} < 0$

Figure IV.8 A Pure Income Effect

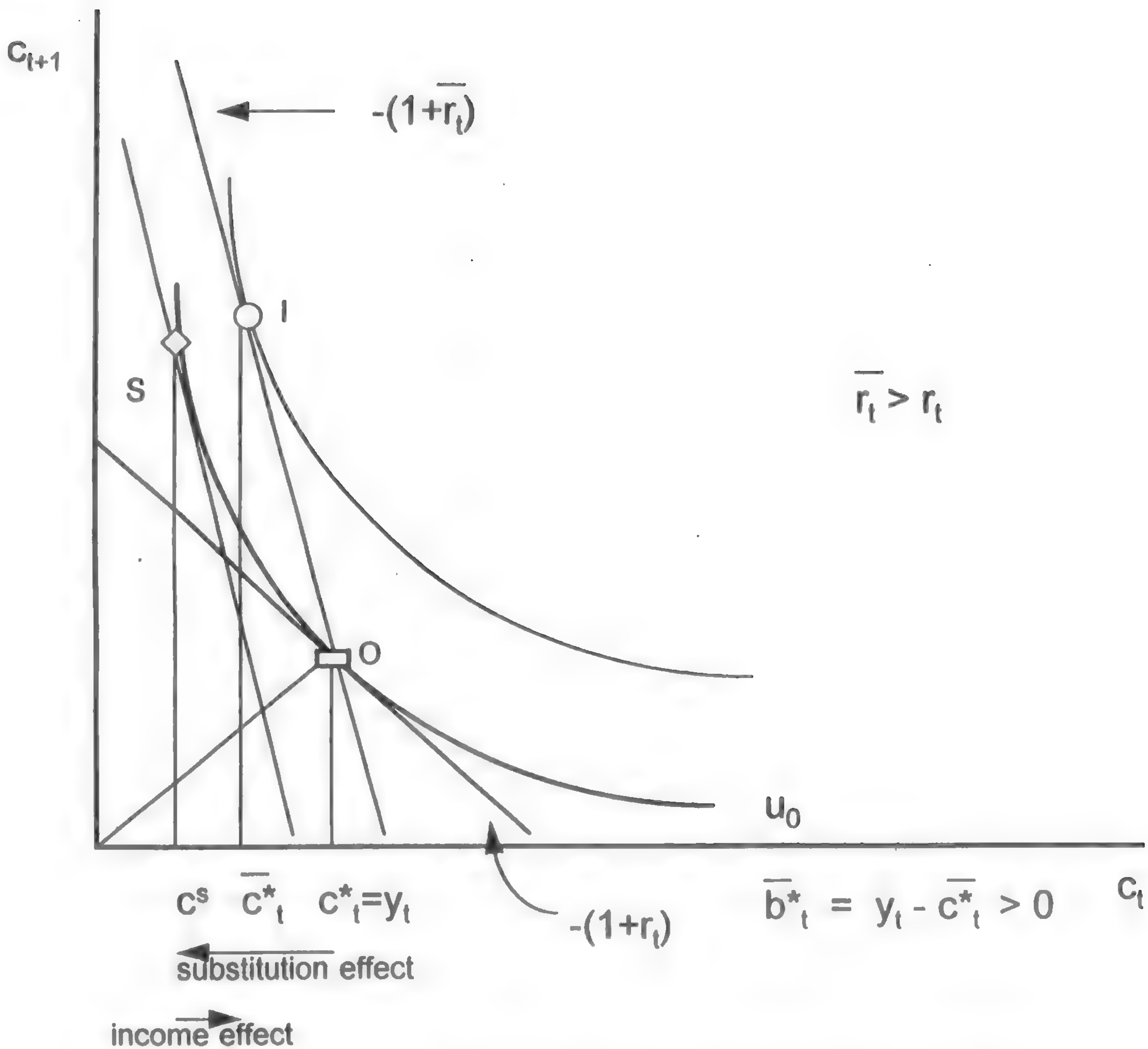


Figure IV.9 Income and Substitution Effects

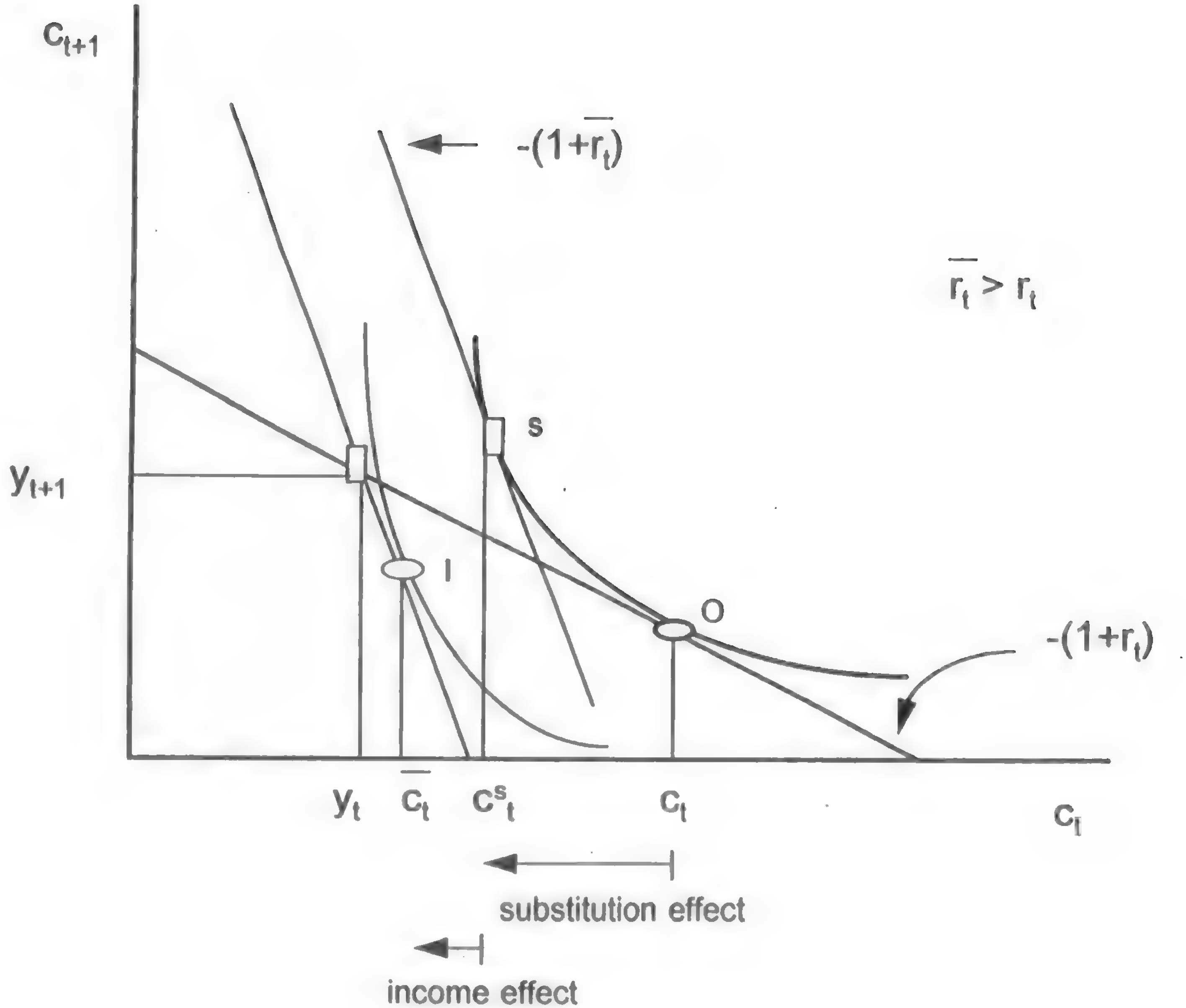


Figure IV.10 Rise in Interest Rates: Borrower

We can use the previous two diagrams to understand the two sides of the bond market, as well as deriving savings and borrowing schedules (like demand and supply curves for bonds). See Figure IV.11.

Notice at the low interest rate $\tilde{r}_t$, Friday wants to borrow more than Rob wants to lend. This would put upward pressure on interest rates. We will study the equilibration process in Chapter V.

The most important thing to notice from this exercise is that we start to understand the why asset markets come to exist.

(a) Differences in endowments

Here, I've emphasized Life-Cycle differences (Modigliani won the Nobel prize in 1987 for studying demographic influences on saving). See Figure IV.12.

I could have also emphasized risk sharing reasons for asset markets.

(b) Differences in Time Preference

If Rob was patient and Friday was impatient, then even if they had the same endowments, they may trade bonds.

E. INTERTEMPORAL SUBSTITUTION OF WORK EFFORT

Let's re-write the IBC to study intertemporal effects on work effort.

$$c_t + \frac{c_{t+1}}{1+r_t} = \theta_t f(n_t) + \frac{\theta_{t+1} f(n_{t+1})}{1+r_t}$$

where θ_t represents technology shocks in t.

(a) Consider an increase in r_t. Then the opportunity cost of leisure in t+1 has fallen relative to leisure in t. In this case I'll substitute out of leisure in period t and into leisure in period t+1. An alternative way to say this is that I'll work more hours today than in the future (i.e. $n_t^s(\overset{+}{r}_t;\theta_t,\theta_{t+1})$ if substitution effects > income effects).

Note: Economists estimate that there is a weak if non-existent link between n_t^s and r_t.

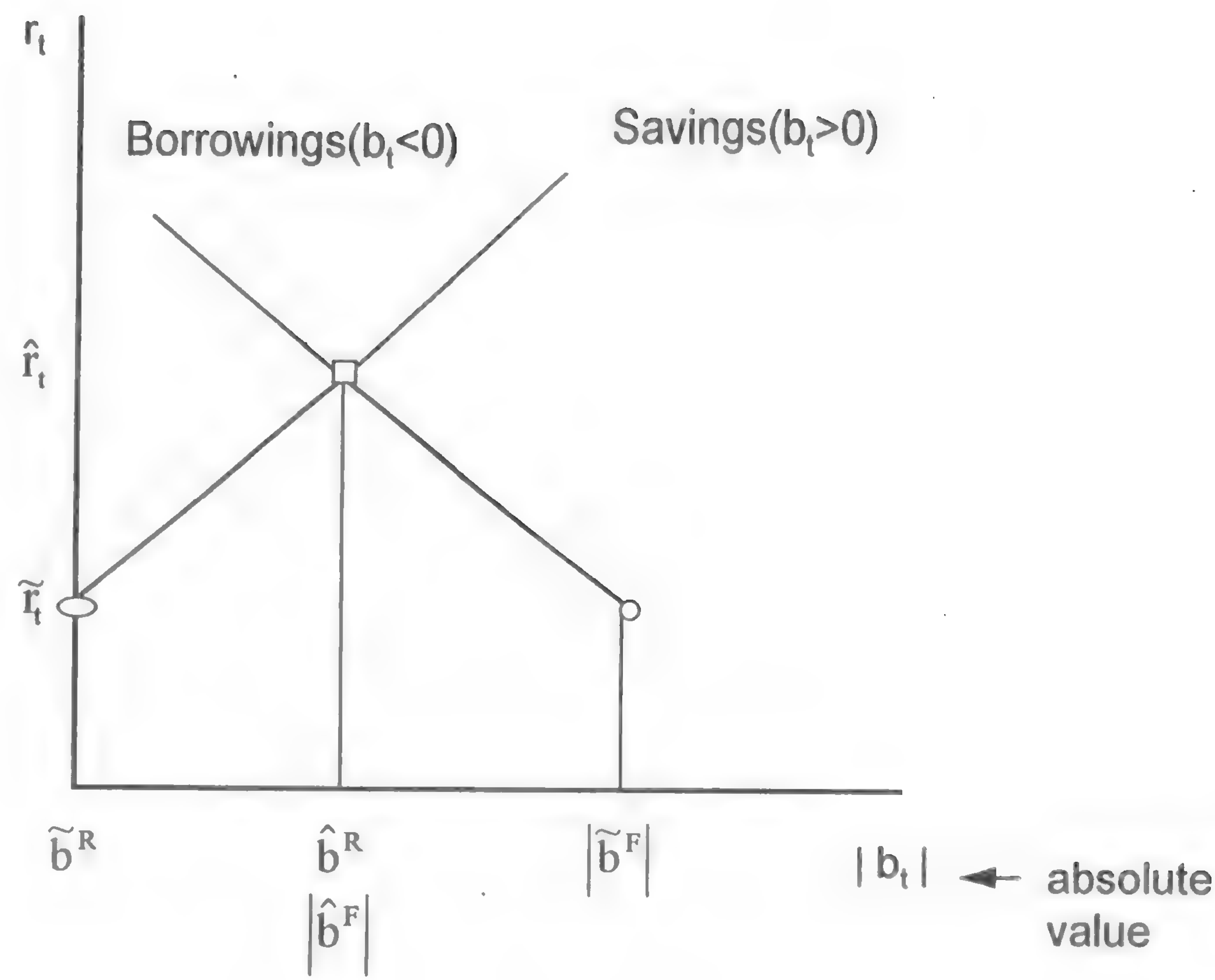


Figure IV.11 Bond Market

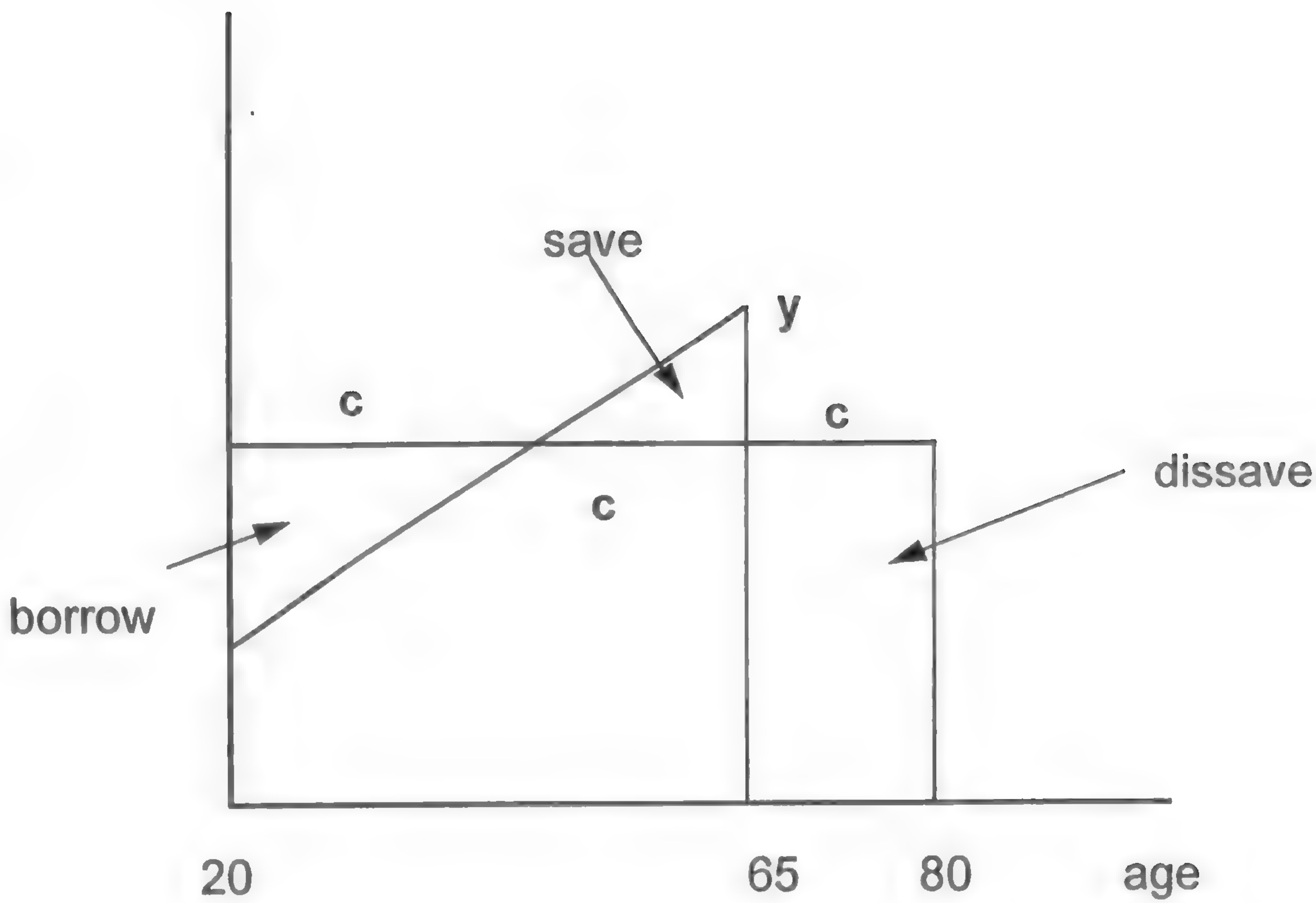


Figure IV.12 Life-Cycle

(b) Consider an increase in θ_t. The opportunity cost of leisure in t rises relative to t+1, so agents substitute out of leisure today and into leisure tomorrow (i.e. $n_t^s(r_t;\overset{+}{\theta_t},\theta_{t+1})$ if substitution > income effects).

(c) Consider an increase in θ_{t+1}. Agents substitute out of leisure tomorrow and into leisure today (i.e. $n_t^s(r_t;\theta_t,\overset{+}{\theta}_{t+1})$ if substitution effects > income effects). So we rest up for a big push. Alternatively think about if agents expect a decrease in θ_{t+1}. In that case, n_t^s rises.

The above shocks were transitory (perceived to last only 1 period). What if θ_t *and* θ_{t+1} rise? That is, what if the shock was permanent?

F. SUMMARY

To study individual savings behavior, we introduced a bond market that enabled individual agents to consume more or less than their income in a given period by selling or purchasing bonds. A bond is just an obligation or claim to $(1+r_t)b_t$ units of the future consumption good in exchange for b_t units of the present consumption good. Thus, the real interest rate r_t is just the relative price of future goods in terms of current goods.

An increase in real interest rates raises the present cost (relative to the future) of demanding an additional unit of today's consumption bundle and today's leisure. This, in turn, induces agents to demand less consumption and less leisure (or supply more labor). Since saving or dissaving in the form of bonds is just the difference between real income and real consumption (i.e. $b_t = \theta_t f(n_t) - c_t$), the rise in real interest rates induces a *marginal* incentive to increase saving or decrease dissaving ($\uparrow b_t = \uparrow y_t - \downarrow c_t$). All of these predictions are based upon substitution effects (the changes in margins alluded to earlier) dominating income effects.[5] Under this assumption, we can derive a standard upward sloping savings curve and downward sloping borrowings curve as a function of interest rates, which we will use to determine equilibrium interest rates in the next chapter.

An increase in present or future productivity also has an important influence on the demand and supply of bonds. For instance, an increase in present productivity ($\uparrow\theta_t$) raises current labor supply (and current real output) as well as raising current consumption. However, since the increase in real income is spent on *both* current *and* future consumption, real income

[5]In fact, a dominant income effect would only reverse the prediction for savers (not borrowers). Why? If interest rates rise, then the interest income of all of your existing savings has risen, which you might want to spend on a new car or a nice bottle of wine.

goes up by more than consumption. That is, savings rise. This intuition is important for why real interest rates may be mildly countercylical.

Suppose that households expect a rise in future productivity. This is analogous to a rise in consumer sentiment. Since the opportunity cost of future leisure has risen ($\uparrow \theta_{t+1}$), agents substitute out of future leisure and into current leisure. This decreases current output, but will raise the present value of income. In that case, households will borrow against future income and consumption should rise. See the Wall Street Journal article about the influence of consumer sentiment on consumption, as well as the article on consumer credit.

Chapter V

A SIMPLE MODEL OF THE DETERMINATION OF REAL INTEREST RATES AND OUTPUT

In the last chapter we simply determined individual agents' quantity choices (like savings and work effort) taking prices as given. In this chapter we turn to the determination of prices.

This chapter will highlight the importance of:

(a) The interrelation of markets in an economy as a whole (termed general equilibrium). We no longer examine markets in isolation (termed partial equilibrium). For example, a technological change in the goods market can *spill over* to the bond market.

(b) How perceptions of future economic activity can affect current interest rates and output.

A. MARKET SPILLOVERS AND WALRAS LAW

Ques: In our simple island economy populated by Robinson Crusoe and Friday, how many markets are there?

Ans: Two. A goods market and a bond market.

Ques: How many prices are there?

Ans: One. The real interest rate, which is the relative price of goods tomorrow in terms of goods today.

Ques: If we find the price at which Demand = Supply in one market (e.g. the equilibrium r^* in the bond market where lending = borrowing), what do we know about the other market?

Ans: It's in equilibrium! This result is a manifestation of the reason why markets are interrelated - the aggregation of individuals' budget constraints imply that markets are not independent of one another. This result is known as *Walras Law*.

Definition. *Market Clearing* occurs when demand = supply.

With two markets,

(1) goods market clearing: $\sum_{j=1}^{J} c_t^j = \sum_{j=1}^{J} y_t^j,$

where c_t^j and y_t^j denotes the consumption and output of a particular individual j where there are J number of agents.

(2) bond market clearing: $\sum_{j=1}^{J} b_t^j = 0$

Now consider the static budget constraint of any individual j:

$$c_t^j + b_t^j = y_t^j + (1+r_{t-1})b_{t-1}^j$$

Now sum up over all agents:

$$\sum_{j=1}^{J} b_t^j = \underbrace{\sum_{j=1}^{J} (y_t^j - c_t^j)}_{\text{equals 0 if goods market clears}} + (1+r_{t-1}) \underbrace{\sum_{j=1}^{J} b_{t-1}^j}_{\text{equals 0 if bond market clears last period}}$$

But this implies $\sum_{j=1}^{J} b_t^j = 0,$ which is just bond market clearing.

Definition. *Walras Law* states that if there are n markets and there is market clearing in n-1 of them, then the nth market clears as well.

This makes our job easy. If we clear the goods market, then we must be clearing the bond market as well.

B. GOODS MARKET EQUILIBRIUM

1) What factors determine the aggregate supply of goods $(\sum_j y_t^j = Y_t^s)$?

(a) r_t: Recall $n_t^j(\overset{+}{r}_t;\theta_t,\theta_{t+1})$

But then $\uparrow r_t \rightarrow \uparrow y_t$ via the production function

(b) θ_t: Recall $n_t^j(r_t;\overset{+}{\theta}_t,\theta_{t+1})$

But then $\uparrow \theta_t \rightarrow \uparrow y_t$ via the production function

(c) θ_{t+1}: Recall $n_t^j\ (r_t;\theta_t,\overset{-}{\theta}_{t+1})$

But then $\uparrow \theta_{t+1} \rightarrow \downarrow y_t$ via the production function

How do we see this graphically? See Figure V.1.

2) What factors determine the aggregate demand for goods $(\sum c_t^j \equiv C_t^d)$?

(a) r_t: Recall $c_t^j\ (\overset{-}{r}_t;\ \theta_t,\ \theta_{t+1})$

(b) θ_t: $c_t^j\ (r_t;\overset{+}{\theta}_t,\theta_{t+1})$ via the income effect, but is spread over both periods' consumption so is small

(c) θ_{t+1} : $c_t^j\ (r_t\ ;\ \theta_t\ ,\ \overset{?}{\theta}_{t+1})$. This is complicated. While the agent may take more leisure today (and hence have less income to spend on consumption goods), she may also borrow against her future income.

How do we see this graphically? See Figure V.2.

To determine real interest rates and real output, we simply superimpose the two graphs. See Figure V.3.

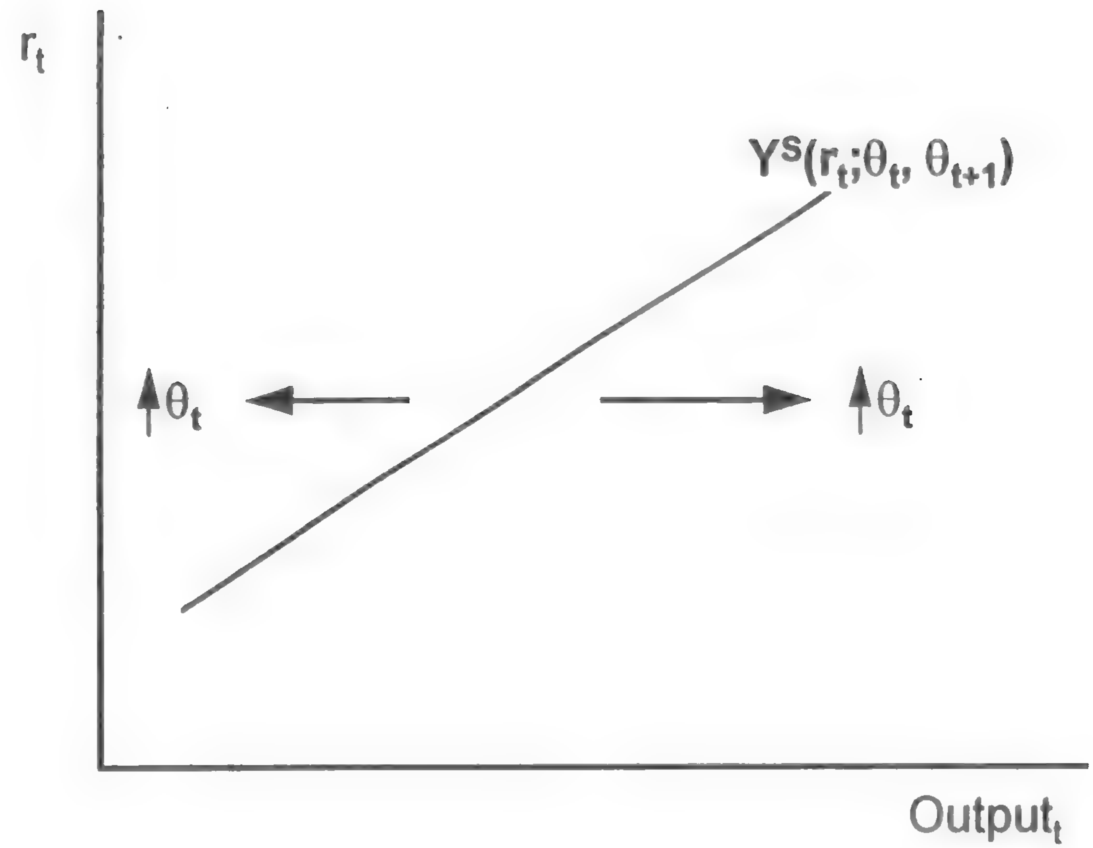


Figure V.1 Aggregate Supply of Goods

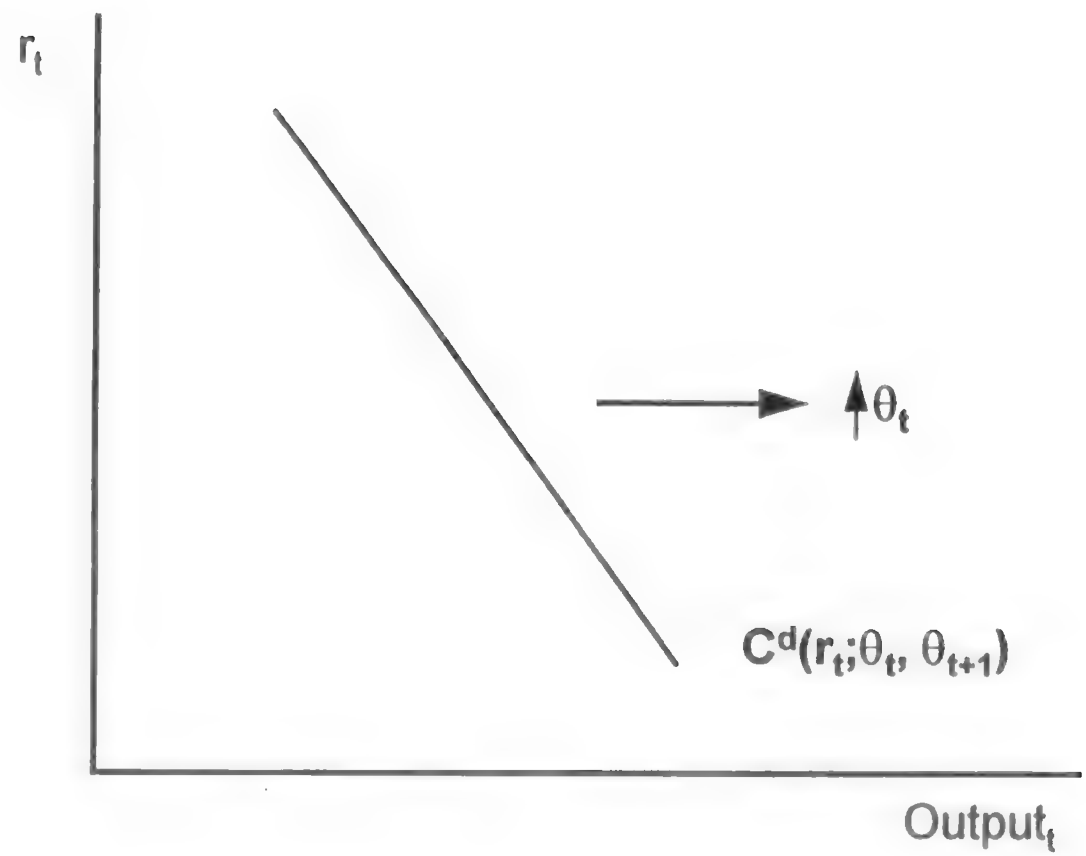


Figure V.2 Aggregate Demand for Goods

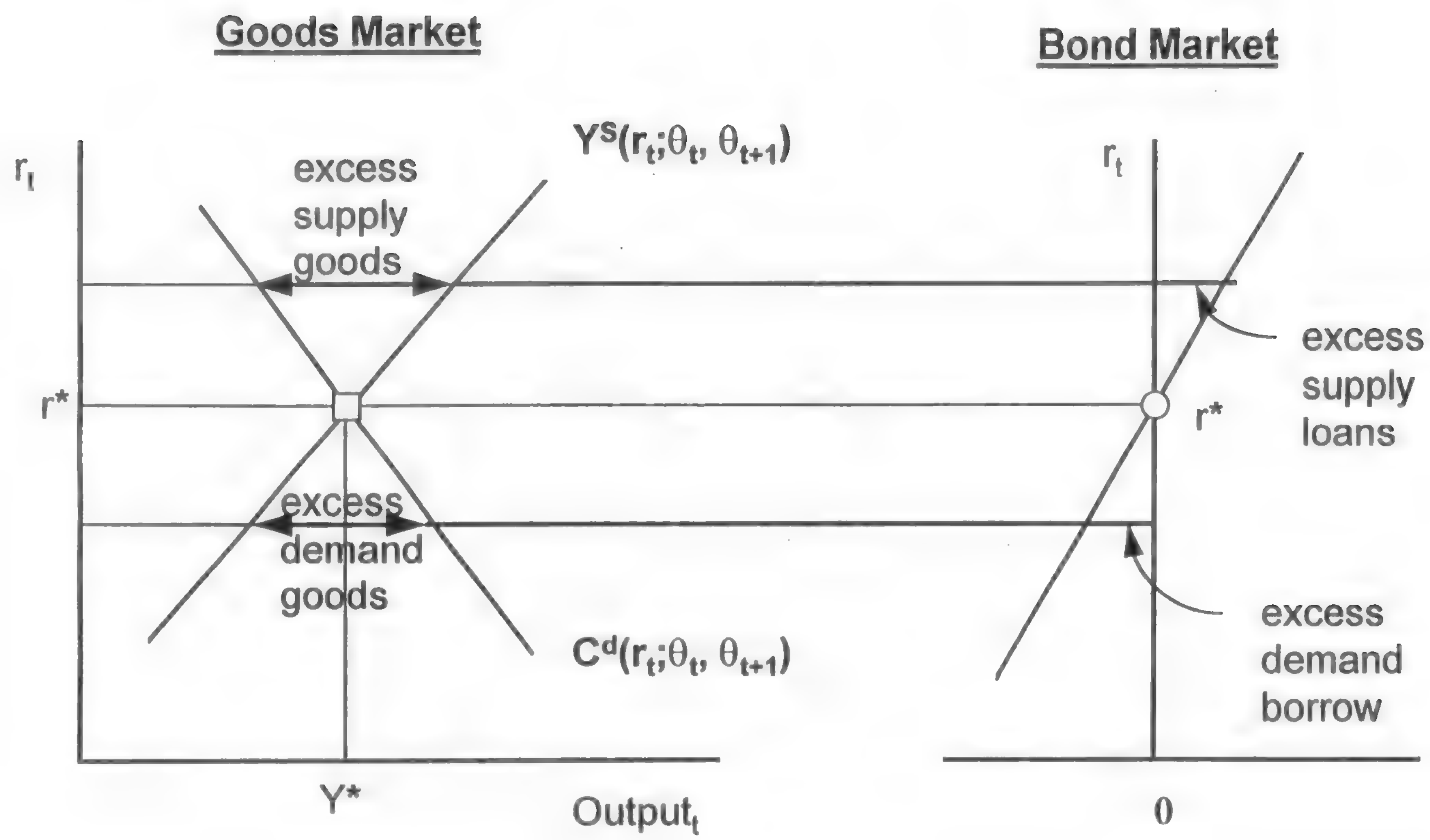


Figure V.3 Real Interest Rates and Real Output

C. THE BEHAVIOR OF REAL INTEREST RATES OVER THE BUSINESS CYCLE

Suppose there's a temporary, negative technology shock (such as the '73-'74 and '79-'80 oil price shocks).

What happens to real GNP and real interest rates?

(a) On the supply side: decrease in θ_t shifts $\underline{Y}^s$ left.

(b) On the demand side: decrease in θ_t temporarily reduces households income, which they can smooth out. This shifts C^d left a little. See Figure V.4.

Result: mildly countercyclical real rates. See Figure V.5.

D. SUMMARY

From the last chapter, having understood how individuals decide to allocate their consumption goods and leisure demand over time, in this chapter we turned to how these decisions determine equilibrium interest rates and output. An equilibrium (state of rest) occurs where demand equals supply. What is at rest is the price (e.g. if there is excess demand for goods the price will rise).

Your intuition might have made you think that if we want to determine interest rates, we should look for bond market equilibrium whereas if we want to determine real output, we should look for goods market equilibrium. Since these two markets are inter-related, if we find equilibrium in one we've found equilibrium in the other. This is Walras Law. For this reason, we study equilibrium in the goods market (Recall, our goods market diagram is graphed in (r_t, Y_t) space, which are our two variables of interest).

We used our model to understand how the economy (in particular what would happen to real interest rates and real GNP) would respond to oil price shocks as in 1973-74 and 1979-80. Oil price shocks are one observable example of a productivity or technology shock. The run-up in oil prices made firms alter their productive process (e.g., it's more costly to run machines at full scale). While firms may search for more efficient (and less oil dependent productive techniques), the immediate impact would be a decrease in productivity.

Since labor is less productive at the margin, the benefit of working an additional hour falls relative to the cost (lost leisure time). This *substitution* effect induces a fall in labor supply. All existing labor hours are also less productive, which effectively means the agent's income has fallen. This fall in income would induce the agent to demand less of both goods (consumption and leisure). This is the *income* effect. If the substitution effect outweighs the

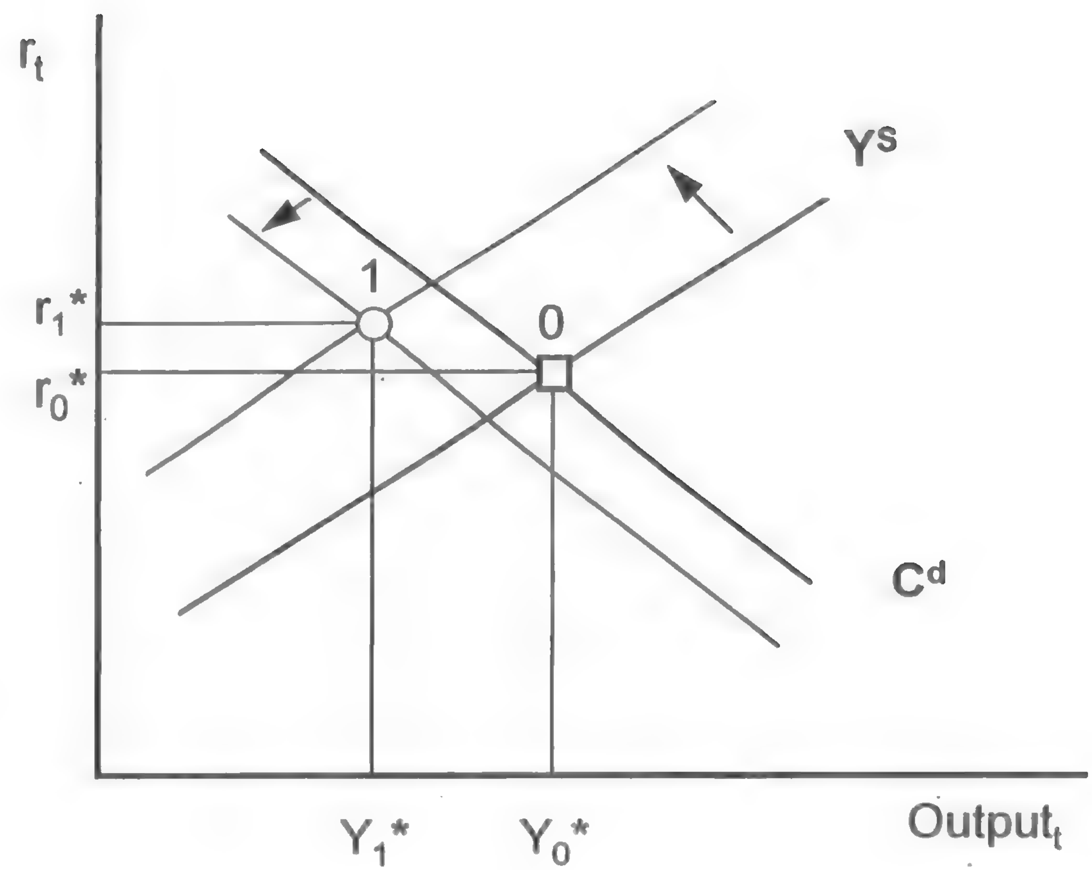


Figure V.4 Effects of a Negative Temporary Technology Shock

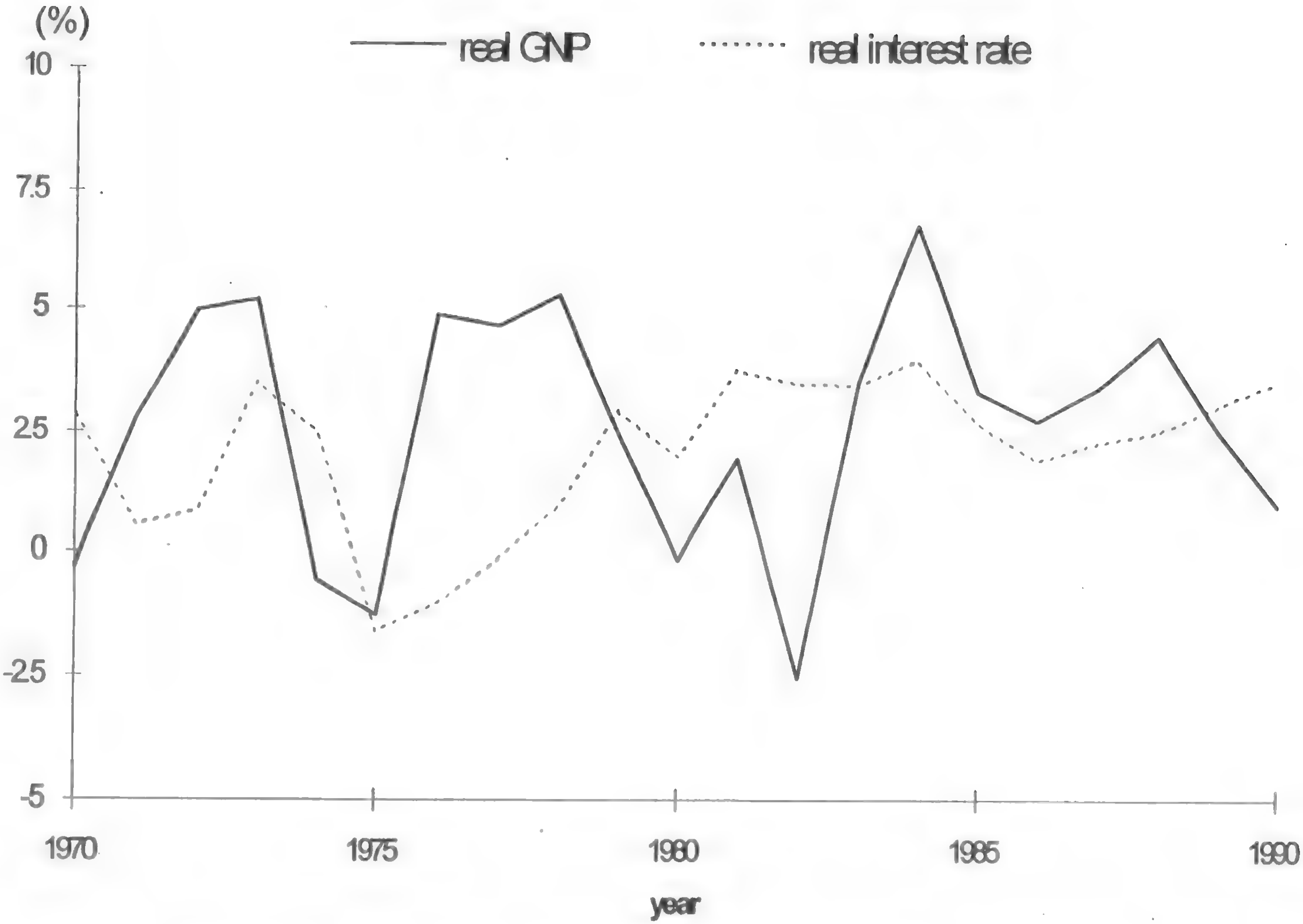


Figure V.5 Growth Rate of Real GNP and Real Interest Rates

income effect, then labor hours and the supply of goods fall. Since income falls, agents consume less. How much less? Data suggests that households desire to smooth consumption. Agents would borrow against their future income to offset the temporary decrease in income. This results in an excess demand for goods today. Since the "economy as a whole" would like to "borrow" to finance this excessive goods demand, real interest rates rise. In summary, the new equilibrium would have higher real interest rates and lower real GNP.

We can also use our framework to understand how changes in preferences and consumer sentiment affect the determination of real interest rates. Later in the class we will expand the model to see how government policies affect real interest rates.

Having determined "real" quantities, we move onto the determination of "nominal" quantities since all prices you read about in the Wall Street Journal are denominated in dollar terms. To determine the dollar price of goods (P_t), we now study money demand and money supply.

Chapter VI

THE MONEY MARKET AND THE DETERMINATION OF THE AGGREGATE PRICE LEVEL

Until now, the only price we've determined is the real interest rate (which is the relative price of goods tomorrow in terms of goods today). Most every price we read about in the Wall Street Journal, for instance, is quoted not relative to consumption goods, but relative to money. So to understand the determination of the aggregate price level (the dollar price of a bundle of goods), we must introduce the money market into our simple model.

This section will highlight

(a) Why people hold money. Once we understand this, we have the demand side of the market.

(b) For a given supply of money (set by the Fed), we can then determine equilibrium P, r, and Y.

A. ON THE DEMAND FOR MONEY

First let's see how money affects a typical agent's budget constraint (I will suppress the notation associated with agent j). Before, the static budget constraint (SBC) was written in *real* terms (i.e. relative to consumption goods). Now we will write it in *nominal* terms:

$$\underbrace{P_t c_t + P_t b_t + m_t}_{\text{nominal uses of funds}} = \underbrace{P_t y_t + P_t (1+r_{t-1}) b_{t-1} + m_{t-1}}_{\text{nominal sources of funds}}$$

where $P_t \equiv$ \$/consumption good at t, $m_t \equiv$ \$ held at t, and recall $b_t \equiv$ real bonds $\equiv$ consumption goods promised at t+1 in terms of consumption goods at t.

There's also a new constraint on agents due to the introduction of money. It is:

$$m_t \geq 0 \text{ , for all t.}$$

This just says you aren't allowed to counterfeit money.

As before, each period t the SBC_t must hold (and I've divided through by P_t)

$$SBC_t \qquad c_t + b_t + \frac{m_t}{P_t} = y_t + (1+r_{t-1})b_{t-1} + \frac{m_{t-1}}{P_t}$$

$$SBC_{t+1} \qquad c_{t+1} + b_{t+1} + \frac{m_{t+1}}{P_{t+1}} = y_{t+1} + (1+r_t)b_t + \frac{m_t}{P_{t+1}}$$

Once again, suppose Rob comes in with no savings or obligations and exits with none.

$$\rightarrow (b_{t-1} = 0 = b_{t+1},\ m_{t-1} = 0 = m_{t+1})$$

Then, once again, we can re-write the sequence of SBC as the intertemporal budget constraint (IBC):

$$c_t + \frac{c_{t+1}}{1+r_t} = y_t + \frac{y_{t+1}}{1+r_t} - \frac{m_t}{P_t}\left[1 - \frac{P_t}{P_{t+1}(1+r_t)}\right]$$

same as before new

Let's consider the new part. Since $\frac{m_t}{P_t}$ is always ≥ 0, the IBC says that if

$1 - \frac{P_t}{P_{t+1}}(1+r_t) > 0$, then my intertemporal sources of funds are lower by the amount:

$$-\frac{m_t}{P_t}\left[1 - \frac{P_t}{P_{t+1}(1+r_t)}\right] \leq 0$$

What is $1 - \frac{P_t}{P_{t+1}(1+r_t)}$? Recall the definition of inflation; it is just the growth rate of prices

or $\Pi_t = \frac{P_{t+1} - P_t}{P_t}$. But then $\frac{P_{t+1}}{P_t} = 1 + \Pi_t$. So I can re-write the expression as:

$$1 - \frac{1}{(1+\Pi_t)(1+r_t)}.$$

Finally, we define the nominal interest rate (R_t) by: $1 + R_t = (1+\Pi_t)(1+r_t)$. So now, the expression is simply given by:

$$1 - \frac{1}{1+R_t} > 0 \Leftrightarrow R_t > 0.$$

Provided nominal interest rates are positive, holding positive amounts of money lowers my PDV of income. While we've seen in the data that real interest rates can be negative, nominal interest rates have always been non-negative.[6]

So why do people hold money? Money is a generally accepted medium of exchange that enables people to avoid a *double coincidence of wants*. e.g. money helps avoid the search costs I would have to incur to find a farmer who wants an economics lecture in exchange for a porkchop.

Once we admit that money has an important transactions role to play in our economy (i.e. we've answered why), the next question to answer is

<u>How Much Money Should I Hold?</u>

Answer: An amount that minimizes the transactions costs γ associated with cash management, as well as the opportunity cost of holding money R_t. The answer to this question is borrowed from the *inventory management* literature.

Story: I get paid $P_t y_t$ at the beginning of the month in the form of a check.

I make a consumption-portfolio savings decision (i.e. choose c_t, b_t, m_t)

How do I undertake the transactions to support my decisions?

---

[6]The argument I've made the last few pages is often made in finance - it is simply an arbitrage argument. If $R_t > 0$, then people would want to set $m_t = -\infty$ (issue money) to finance $b_t = +\infty$. You could make ∞ profits out of thin air (but be thrown into jail)!

I cash the check at the bank, incurring γ, purchase or sell bonds, and have beginning of period cash balances M_t

$$M_t = P_t y_t - P_t b_t - P_t \gamma$$

We use these beginning-of-period (M_t) cash balances to consume continuously throughout the month

$$P_t c_t + m_t = M_t$$

Notice, this is just another way to write the (SBC_t) when $b_{t-1} = 0 = m_{t-1}$. See Figure VI.1.

What is this agent's average real money balances over the period given that she only made one initial bank trip ($\eta = 1$)?

Ans: $\dfrac{\overline{m}_t}{P_t} = \dfrac{c_t}{2 \cdot 1}$

Suppose that the agent held half the initial money balances, so that she could purchase more bonds and earn more interest. Then, halfway through the period, she goes to the bank, liquidates the bond, incurs the cost γ and consumes at the same rate as before. See Figure VI.2.

Now what is the agent's average money balances given that she makes 2 trips?

Ans: $\dfrac{\overline{m}_t}{P_t} = \dfrac{c_t}{2 \cdot 2}$

In general, if the agent makes η_t trips, average real money balances = $\dfrac{c_t}{2 \cdot \eta_t}$

So what are the tradeoffs to cash management?

a) Keep average money balances low in order to earn higher returns in other assets (i.e. opportunity cost to holding money is R_t)

b) Each bank incurs a real cost γ

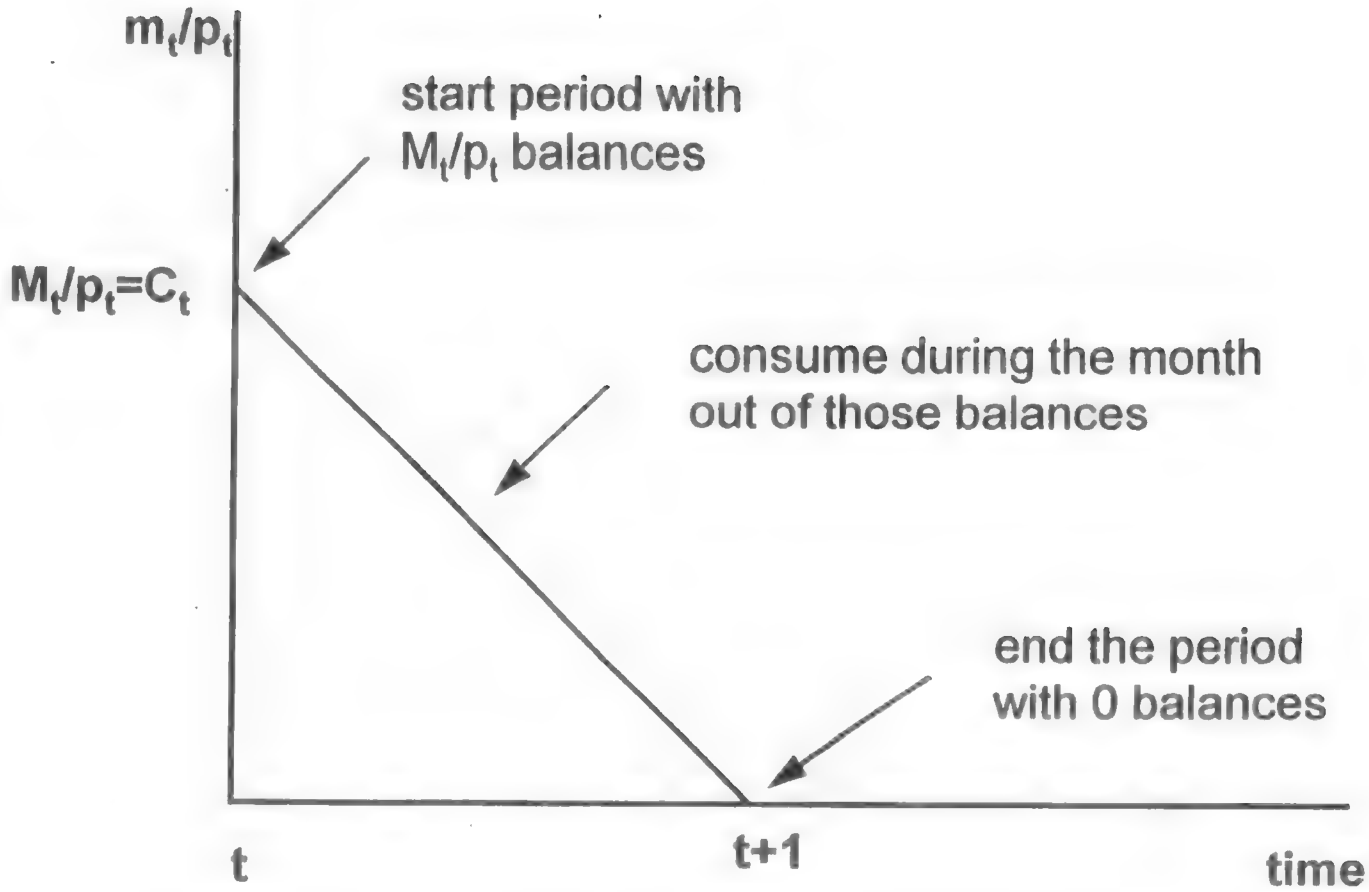


Figure VI.1 Cash Balances over Time: One Transaction

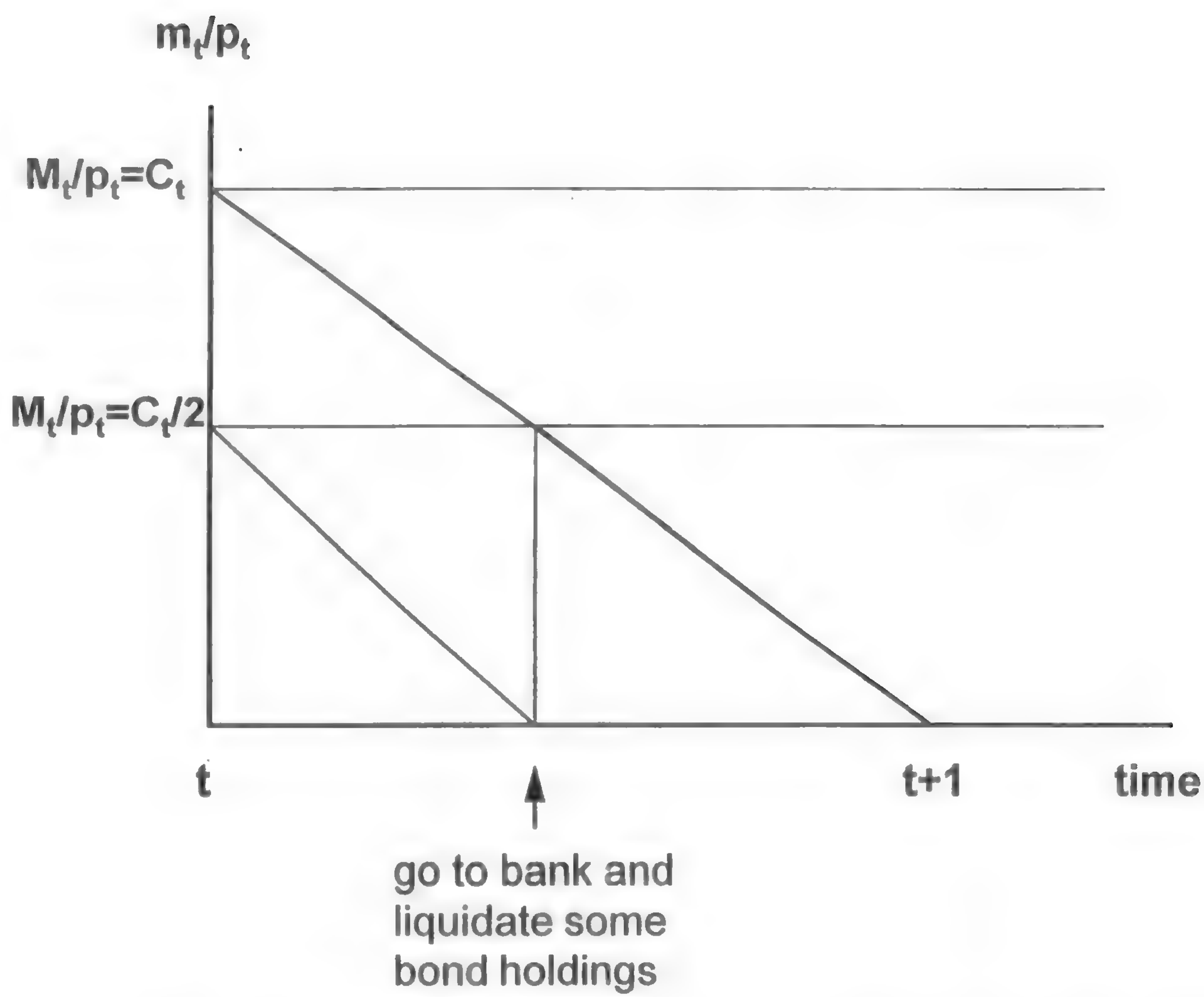


Figure VI.2 Cash Balances over Time: Two Transactions

The total cost of cash management for individual j is:

$$\underbrace{\frac{R_t c_t^j}{2\eta_t^j}}_{\text{opportunity cost}} + \underbrace{\gamma \eta_t^j}_{\text{brokerage fees}}$$

See Figure VI.3.

The minimum of the Total Cost curve for individual j occurs where

$$\gamma \eta_t^j = \frac{R_t c_t^j}{2\eta_t^j}$$

or

$$\eta_t^j = \sqrt{\frac{R_t c_t^j}{2\gamma}}$$

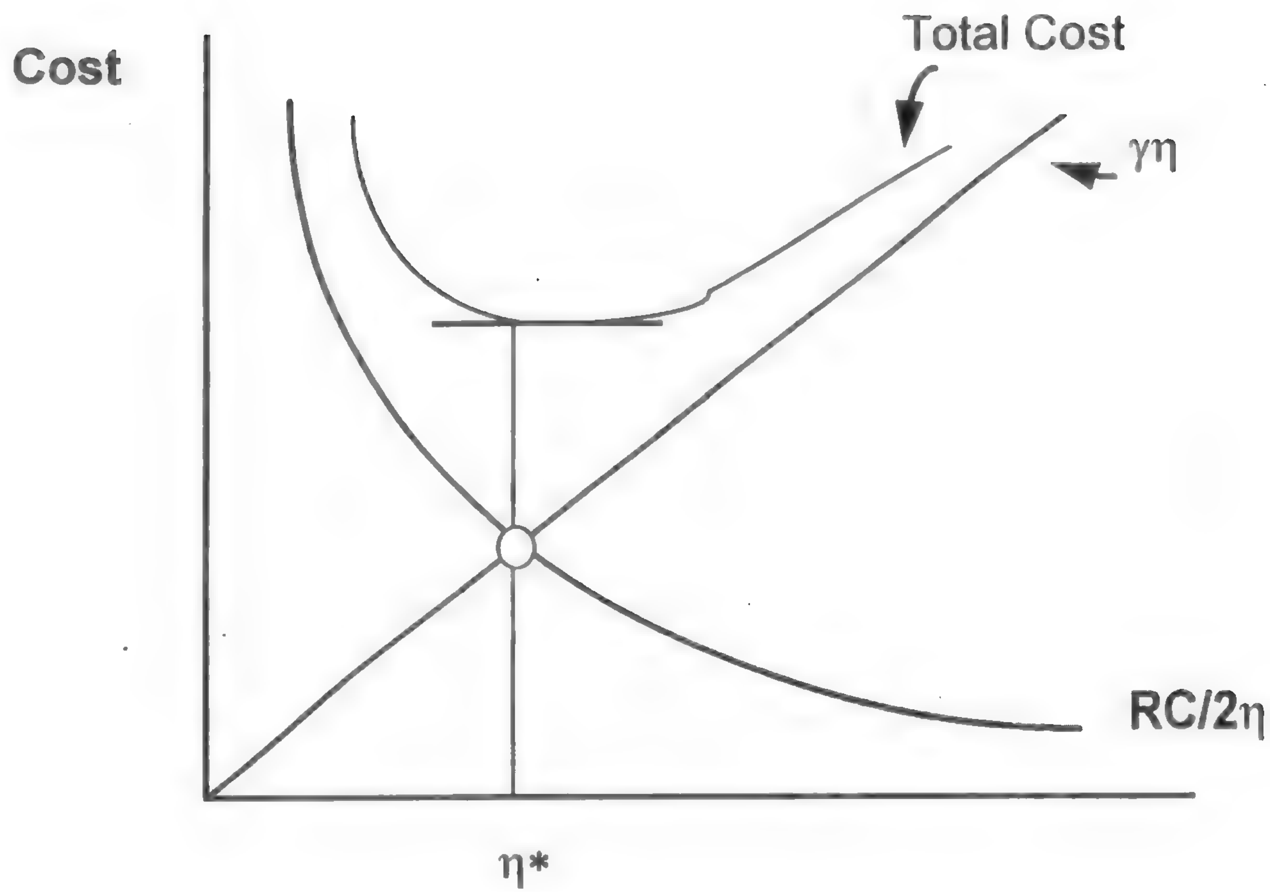
This is the famous square root rule of the (S,s) inventory management policy.

Therefore, agent j goes to the bank more often if:

(a) Nominal interest rates rise (R_t)
(b) Her real expenditure rises (c_t^j)
(c) Transactions costs fall (γ)

Since average real money balances held by agent j are related to her number of bank trips by:

$$\frac{\overline{m}_t^j}{P_t} = \frac{c_t^j}{2\eta_t^j}$$



Optimal number of bank trips occurs at the minimum of total cost curve η^*

Figure VI.3 Optimal Number of Bank Trips

we can make predictions about how changes in, e.g. interest rates, affect money demand. That is,

$$\frac{\overline{m}_t^j}{P_t} = L^j(\overset{-}{R_t}, \overset{+}{c_t^j}, \overset{+}{\gamma})$$

To study the money market, we need aggregate money demand

$$M_t^d = P_t \sum_{j=0}^{J} L^j(\overset{-}{R_t}, \overset{+}{c_t^j}, \overset{+}{\gamma})$$

That is, the aggregate demand for nominal money balances are proportional to the aggregate price level. See Figure VI.4.

B. MONEY MARKET EQUILIBRIUM

To finish out the market, we need money supply. For the time being (until next chapter), we will simply assume that the money supply is exogenously fixed by the Fed, independent of the state of the economy (in particular, independent of P_t). See Figure VI.5.

So we've just determined the equilibrium price level.

Let's return to our oil price (productivity) shock example. Recall, $\theta_t \downarrow$, $\uparrow r_t$, $\downarrow Y_t$, $\downarrow C_t$.

Ques: What happens to the price level? See Figure VI.6.

Ans: The *price level* is countercyclical. This matches with the data. See Figure VI.7.

To generate the countercyclical price level result we used the goods market and money market diagrams only, despite the fact that there's another market (bonds).

Ques: What allows us to do this?
Ans: Walras Law.

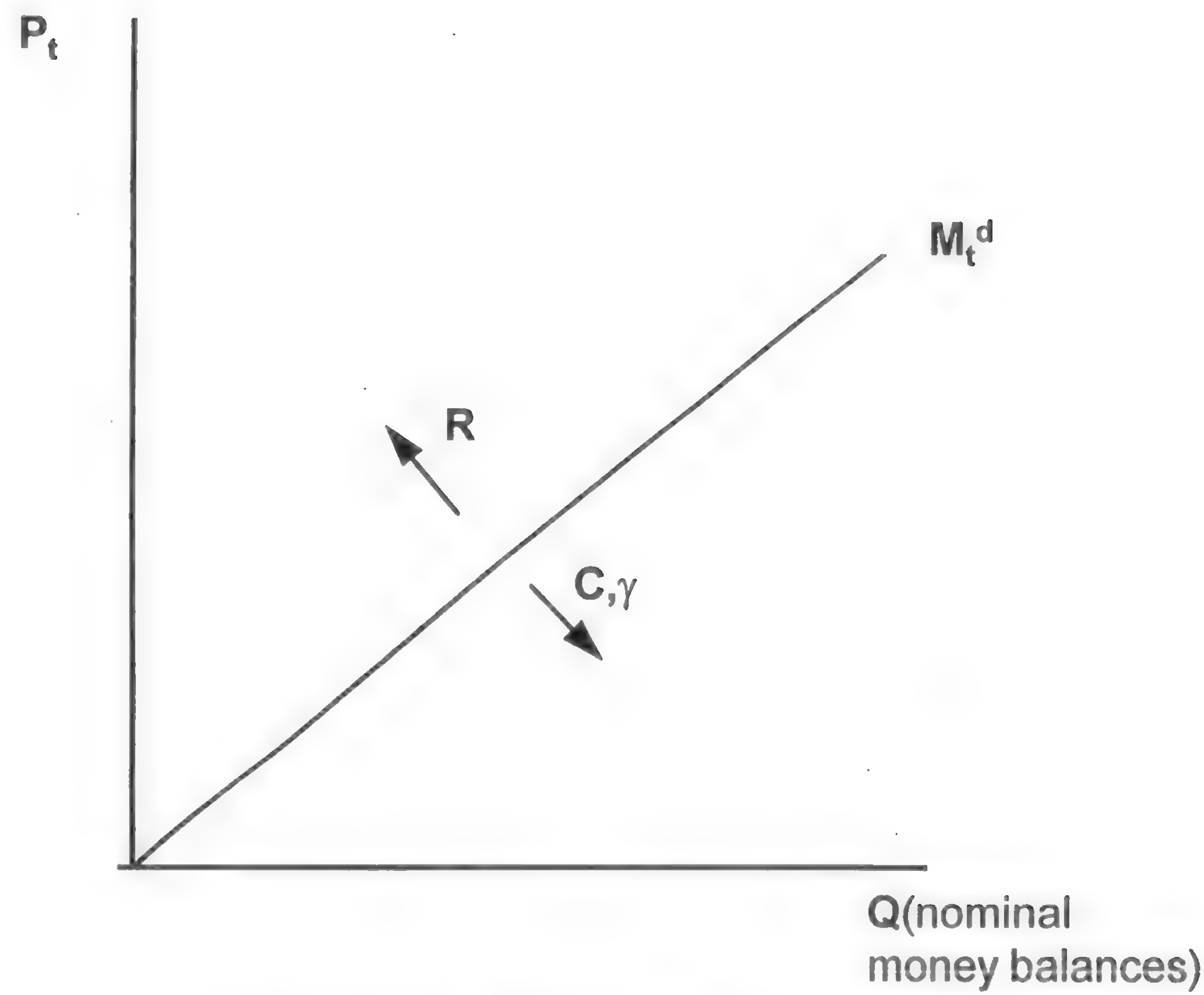


Figure VI.4 Money Market

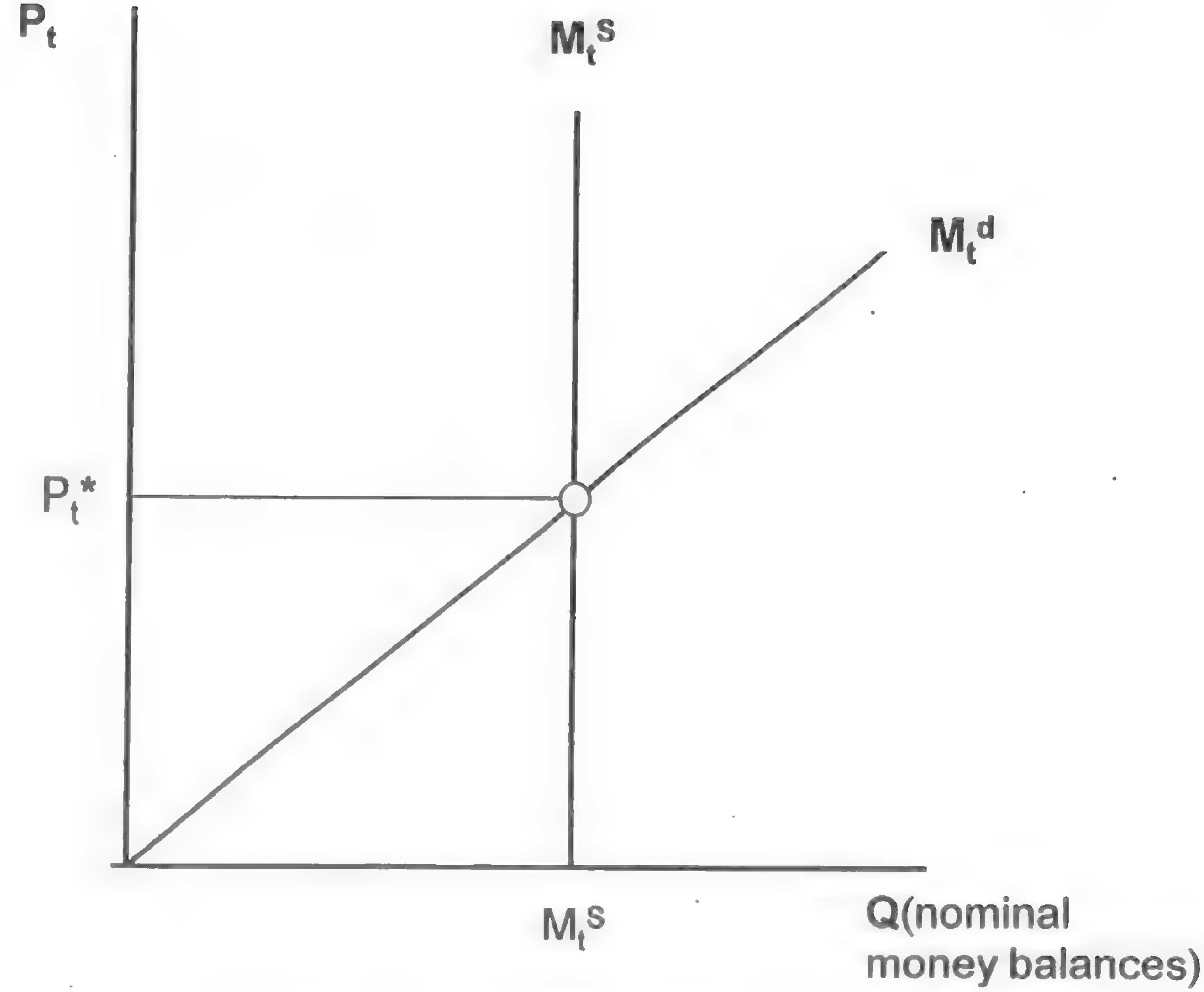


Figure VI.5 Price Level in Money Market

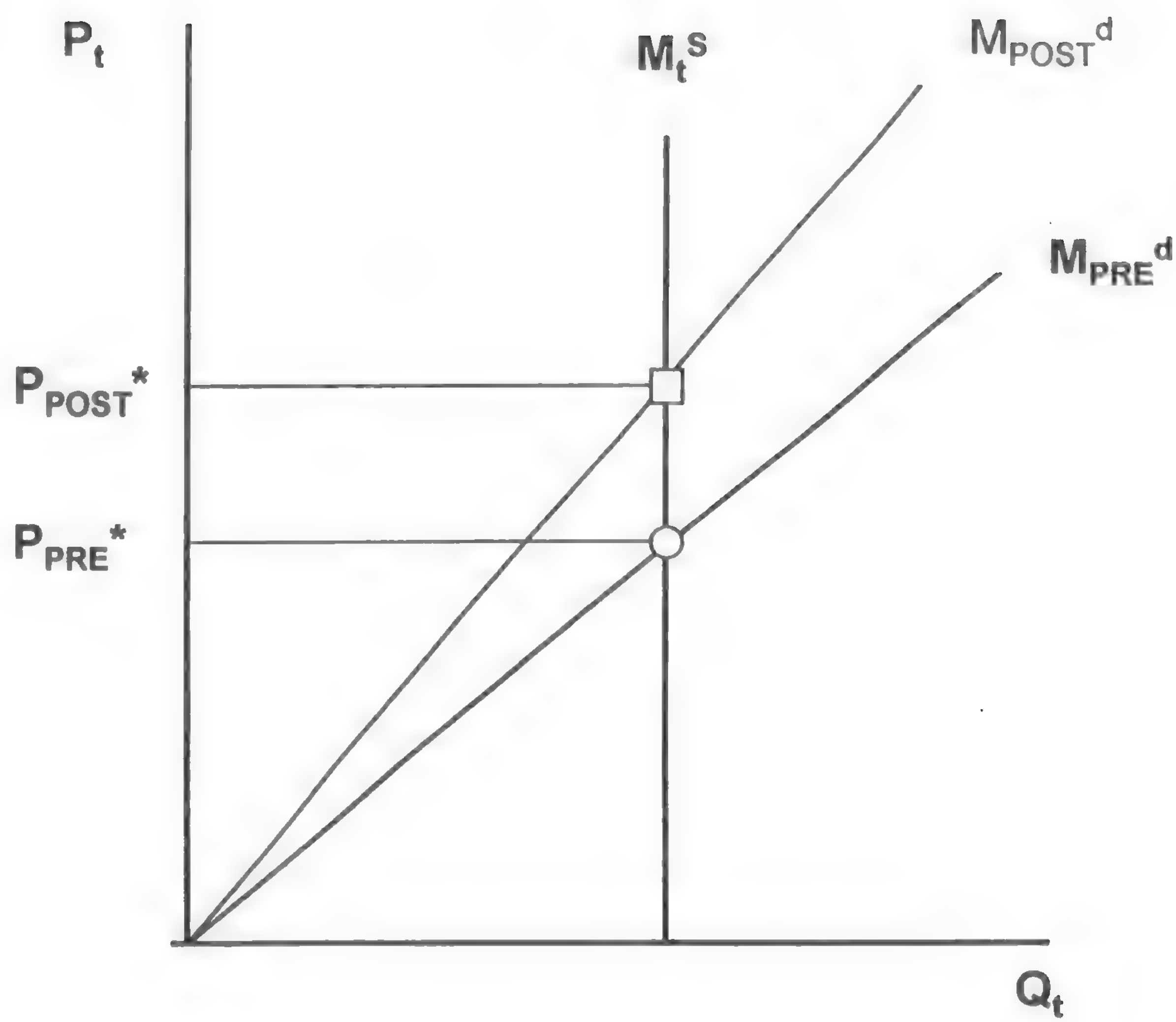


Figure VI.6 Effects of a Productivity Shock

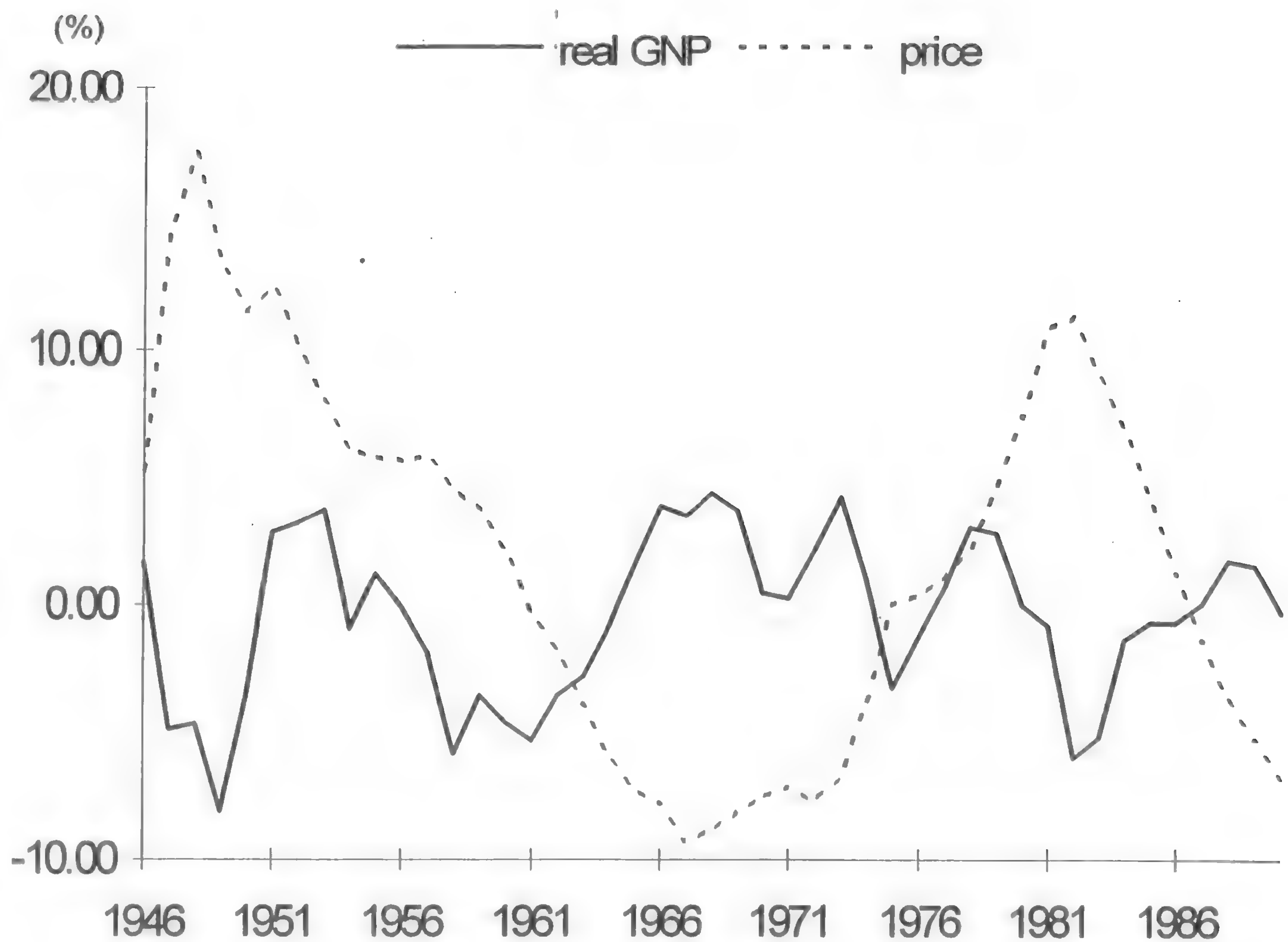


Figure VI.7 Deviation from Trend: Real GNP and Price Level

How do we see this? Rearranging each agent's budget constraint, and summing up over all agents we have:

$$\sum_{j=1}^{J} b_t^j = \sum_{j=1}^{J} \left(y_t^j - c_t^j - \eta_t^j \gamma\right) + \frac{1}{P_t} \sum_{j=1}^{J} \left(m_{t-1}^j - m_t^j\right) + (1+r_{t-1}) \sum_{j=1}^{J} b_{t-1}^j$$

$\uparrow$

consumption of financial services

Past market clearing $\rightarrow$

$$\sum b_{t-1}^j = 0, \sum m_{t-1}^j = M_{t-1}^S \text{ (i.e. past money demand = money supply)}$$

Since the money supply hasn't changed over time in this example, $M_{t-1}^s = M_t^s$.

$$\sum_{j=1}^{J} b_t^j = \sum \left(y_t^j - c_t^j - \eta_t^j \gamma\right) + \frac{1}{P_t} \left(M_t^s - \sum m_t^j\right)$$
$$= 0 + 0$$

C. THE QUANTITY THEORY OF MONEY

Having just determined the *price level* P_t, we move into our study of the growth rate in prices or *inflation* Π_t. As Milton Friedman put it, "Inflation is always and everywhere a monetary phenomenon." (1968, p. 29 in Dollars and Deficits Prentice Hall)

When we developed our theory about money demand, we showed that an agent's average money balances were determined to be:

$$\frac{\overline{m}_t^j}{P_t} = \frac{c_t^j}{2\eta_t^j}$$

For the economy as a whole we represent this as the Quantity Equation (QE):

$$M_t^s V_t = P_t Y_t$$

where V_t, or velocity, just represents the number of times that a typical dollar circulates and is obviously related to the average number of bank trips (η) that individuals make. We've also substituted in the market clearing conditions $M_t^d = M_t^s$ and $C_t^d = Y_t^s$.

The two sides of the Quantity Equation (QE) measure the dollar volume of transactions in the economy. It is a virtual identity, and a useful one at that.

Let's rewrite the QE in percentage change form (to an approximation):

$$\%\Delta \text{ in } M + \%\Delta \text{ in } V = \%\Delta \text{ in } P + \%\Delta \text{ in } Y$$

or

$$\Pi = \mu + \%\Delta \text{ in } V - \%\Delta \text{ in } Y$$

which says that inflation is related to the growth rate of the money supply and factors which depend upon real growth (e.g. output) in the economy).

In the high money growth countries, the link between μ and Π is strong. In low money growth countries, real factors sever the close link.

	Π	μ	$\Delta Y/Y$	$\Delta V/V$	Time
Brazil	77.8	77.4	5.6	6.0	'63-90
Argentina	76.0	72.8	2.1	5.3	'52-90
Israel	29.4	31.0	6.7	5.1	'50-90
U.K.	6.5	6.4	2.4	2.5	'51-90
France	6.2	7.0	4.1	3.3	'50-90
Japan	4.7	11.2	6.9	0.4	'53-90
U.S.	4.2	5.7	3.1	1.6	'50-90
W.G.	3.0	7.0	4.1	0.1	'53-90

D. INFLATION AND NOMINAL INTEREST RATES

Now that we have established the link between μ and Π, we are ready to understand the link between μ and R. Because a lender (of dollars) will want to be compensated for erosion of the value of dollars when she ultimately receives them back, she will not lend unless nominal interest rates incorporate an inflation premium. In this way, we will see the relation between μ and $R = r + \Pi$.

If an agent lends \$1 at t, she receives \$1 + R_t at t+1.

If an agent lends 1 good at t, she gives up \$$P_t$ to receive \$$(1+R_t)P_t$ at t+1, and receives $\frac{(1+R_t)P_t}{P_{t+1}}$ goods at t+1. We rewrite the number of goods she receives as $\frac{(1+R_t)}{(1+\Pi_t)}$ or $1+r_t$.

In this case, by definition (with a slight approximation that $\Pi_t \cdot r_t \approx 0$) $R_t = r_t + \Pi_t$.

Since agents don't consume dollars but goods, the relevant opportunity cost of consuming today is given by the real interest rate.

Here we note the relevant returns on money and bonds:

	Money	Bonds
nominal interest	0	R_t
real interest	$-\Pi_t$	r_t

E. THE CLASSICAL DICHOTOMY

Our model exhibits a property called the *classical dichotomy*. The real interest rate is determined solely in the goods market by "real" factors such as preferences and technology. Given r_t, the nominal interest rate is determined by the money market through the link between μ and Π.

Where does this "delinking" of real and monetary factors arise from in the model?

Recall, when we added money to the model we arrived at the IBC:

$$C_t + \frac{C_{t+1}}{1+r_t} = \theta_t f(n_t) + \frac{\theta_{t+1} f(n_{t+1})}{1+r_t} - \frac{m_t}{P_t}\left[1 - \frac{1}{1+r_t+\Pi_t}\right] - \eta_t \gamma$$

Furthermore, recall that since $R_t > 0$, agents would economize on money balances, choosing end-of-period money balances $\frac{m_t}{P_t} = 0$. In that case, Π_t doesn't influence the IBC directly

(i.e. $1-\frac{1}{1+r_t+\Pi_t}$ is zapped out).

The only place where Π_t then influences the IBC is through wealth effects associated with transactions costs of cash management (i.e. $\eta_t \cdot (r_t+\Pi_t,..)$ But since γ is typically small, we neglect this affect for the time being.

Since preferences don't explicitly depend on prices and the IBC doesn't either, then consumption and labor supply decisions are insulated from the money market.

Suppose now that preferences and technology are not changing. In that case Y and r (determined in the goods market) are not changing.

Then by the QE (since $\%\Delta Y = \%\Delta V=0$), we have

$$\Pi = \mu$$

in which case

$$R = r + \mu$$

So increases in money growth rates lead to rising nominal interest rates. This is why the Fed argues that tight monetary policies ultimately keep nominal interest rates low.

F. SUMMARY

This chapter introduced another asset market: money. We paid particular attention to the demand side of the market.

First we asked, why do people hold money? As a store of value, we showed that money was dominated by other assets (in our particular model, dominated by bonds). That is, one dollar today yields one dollar in the future. On the other hand, one dollar invested in a bond today yields $1+R$ dollars in the future. Given that nominal interest rates are positive, money is dominated by another safe asset and should not be held in one's portfolio (we showed this formally by manipulating an agent's budget set in the same way that arbitrage arguments proceed). This suggested that money is not held *simply* as a store of value. Rather, we argued that it cuts down on the cost of searching for someone who has a double coincidence of wants.

This enables people to specialize in the production of one good while consuming many goods. Thus, money supports economic efficiency through its function as a medium of exchange.

If money has become an accepted medium of exchange, then how much money should people hold on average? On one hand, the above argument obviously suggests that the agent should keep as much of her portfolio in the form of interest earning assets (i.e. hold as little money balances as possible). On the other hand, if money is the medium that we use to purchase consumption goods, then we must have sufficient amounts available to enable us to undertake our desired consumption flow over time. If we fell short of cash, we would have to liquidate our interest earning asset (call our broker or walk to the bank) which is also costly. The optimal amount of money to hold balances these two competing costs (these types of competing costs should be familiar to any inventory manager who wants to keep his shelves at a level that balances the storage costs of the good against the costs of stockouts). Using this as a guide, we showed that an agent's average *real* money balances would fall as nominal interest rates rise (sort of a substitution effect) and rise as real expenditure or income rises (sort of an income effect). The analysis also predicts that *nominal* money holdings are proportional to the aggregate price level. For evidence of this, I will provide data on the German hyperinflation.

We then incorporated these predictions for money demand into a diagram characterizing the money market in (P_t, M_t) space. We showed that since an oil price (or negative productivity) shock predicted a rise in r_t and a fall in Y_t, both of which would decrease agents' demand for nominal money balances, the resulting excess supply of money would put upward pressure on the price level P_t. This would result in countercyclical prices, a prediction consistent with the data.

After understanding the determination of the price level, we move onto understanding the determinant of the growth rate of prices. We formalize Milton Friedman's famous adage "Inflation is always and everywhere a monetary phenomenon." We manipulated the money market clearing condition, where money demand is simply aggregate average money balances held, to generate the quantity equation; $M \cdot V = P \cdot Y$. If variations in velocity and output are small, then we can see the close relation between money supply growth and inflation predicted by the quantity equation.

Our goods and money market diagrams provide a simple "dichotomous" breakdown of the determinants of nominal interest rates; preferences and technology determine real interest rates in the goods market (r_t) and money supply growth determines inflation in the money market (π_t). Since lenders will want to be compensated for the decline in the purchasing power of dollars over time, they will incorporate an inflation premium over the real interest rate in the determination of the nominal interest rate (i.e. $R_t = r_t + \pi_t$).

It's actually a little too strong to say *dichotomy* (which means mutually exclusive), since

we've seen that real output growth affects prices and inflation in the money market diagram. But unless we account for real wealth effects on consumption associated with cash management to avoid inflation, the model we've been studying has the property that the real side of the economy is insulated from the monetary side (later in the semester we will see that imperfect information can mean that monetary factors have real effects).

The implications for monetary policy of this characteristic of the model is that $R_t = r_t + \mu$. That is, nominal long term interest rates are positively related to money growth through money's influence on inflation. Furthermore, real interest rates should be unaffected by money growth. These are two hypotheses that we can, and will, test in the data.

Chapter VII

THE MONEY SUPPLY PROCESS

To understand the rate of growth of prices, we need to understand the rate of growth of the money supply, which we will identify as M1. M1 is defined as currency and checkable deposits. This definition identifies the two principal actors in the money supply process: the Federal Reserve and commercial banks.

A. THE FED

Some institutional details: Made up of 12 regional banks and the Board of Governors in Washington. Established in 1914 primarily as a "lender of the last resort". (Before 1914, a group of large N.Y. banks acted as the L-O-T-L-R but this system broke down). So you can see that the Fed was developed as a way of lending funds to banks in desparate need. This is the basis for one of its important policy instruments:

1) The Discount Window

But since the 1930's, by far the most important instrument for affecting the money supply has been:

2) Open Market Operations

An infrequently used instrument is:

3) Reserve Requirements

(That is, Commercial Banks are required to hold 12% of their checkable deposits in reserve)

B. FINANCIAL INTERMEDIARIES[7]

At any point in time, there are borrowing and lending agents in our economy. The primary borrowers in our economy are businesses (and the government). The primary lenders are households.

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[7]For an extremely detailed discussion, see Marcia Stigum (1983) The Money Market, Illinois: Dow Jones-Irwin, especially Ch. 2.

Businesses obtain external financing for capital expenditure either directly (through primary securities like stocks and bonds) or indirectly (through indirect securities like bank loans).

Intermediaries like commercial banks, savings & loans, life insurance companies, and mutual funds indirectly channel funds from lenders to borrowers.

The main reason for such intermediation is that the mix of primary securities offered by borrowers is unattractive to lenders. With the exception of corporate stocks, the minimum denominations on many primary securities are high relative to the size of individual savings. Also, the maturity of debt issued by borrowers typically exceeds the desired liquidity of lenders. Therefore, intermediaries have a role to *pool* the resources of "small lenders" and funnel these funds to "big borrowers". Pooling diversifies risk and overcomes the minimum denominations problem.

Commercial banks are a special intermediary for two reasons:

(a) They are the largest intermediary
(b) They "create" money

COMMERCIAL BANK CREATION OF MONEY

Here we try to understand the money supply process through Fed and Commercial Bank Balance Sheets

Simplified Fed Balance Sheet

Assets	Liabilities
Govt Securities (DC_F)	Currency (CUR)
Foreign Exchange Reserves (X)	Comm. Bank Reserves (CBR)

Note: We define the *monetary base* as currency and commercial bank reserves (i.e. the main liability of the Fed)

Simplified Commercial Bank Balance Sheet

Assets	Liabilities
Govt Securities & Loans (DC_{CB})	Checkable Deposits (D)
Reserves (CBR)	

The consolidated balance sheet can help us understand the definition of M1.

Consolidated Balance
Sheet

Assets	Liabilities
DC_F	CUR
DC_{CB}	D
X	
CBR	CBR
DC+X	$C_u+D \equiv M1$

Now suppose that the Fed wants to increase reserves and ultimately the money supply. How does it do it? Its primary vehicle is open market purchases of government securities. Consider a $1 million Open Market Purchase.

Fed

A	L
+1 DC_F	+1 CBR

Impact effect

Comm. Bank

A	L
-1 Govt Sec	
+1 CBR	

Since CBR do not earn interest, what will commercial banks do with these funds? Make loans that do earn interest.

Comm Bank

A	L
-1 Govt Sec	
+1 Loans	

What happens to these loans? The agents who sold the goods which borrowers bought ultimately deposit it in some bank.

What happens to these deposits? Banks keep some in reserve (required reserves by Fed are 12% of deposits and possible excess reserves) and lend the rest out.

Comm Bank

A	L
-1 Govt Sec	
+ Loans	
+.12 CBR	+1 D
+.88 Loans	

What happens to the newest round of loans? Just as before.

And the newest round of deposits? Just as before.

Comm Bank

A	L
-1 Govt Sec	
+1 Loans	
+.12 CBR	+1 D
+.88 Loans	
+.11 CBR	+.88 D
+.77 Loans	

We would keep on repeating this process. So now what ultimately happen to M1? Since checkable deposits (D) are one component of M1, just add them all up.

+1 + .88 + .77 + ...

More generally, let ΔMB be the size of the original increase in CBR and let $re \equiv$ CBR/D. Then $\Delta M = [1+(1-re)+(1-re)^2+\ldots]\Delta MB$. This infinite expansion can be represented as: $\frac{1}{1-(1-re)}$ or $\frac{1}{re}$. In this case, a \$1 million open market purchase leads to an \$8.333 million increase in M1.

What if the agents who sold the goods which borrowers bought did not deposit *all* their funds in a commercial bank but instead held some currency?

In that case banks can't make as many loans, which means there's not as many deposits, which means there's not as many loans, which means...ultimately this means M1 won't grow as much.

To formalize this we need some definitions.

(1) $M = CUR + D \equiv (cu + 1)\,D$

where we have defined *cu* as the ratio of Currency to Deposits (i.e. $cu = \frac{CUR}{D}$)

Furthermore,

(2) $MB = CUR + CBR \equiv (cu + re)\,D$

Substituting (2) into (1) we have

$$M = \frac{1+cu}{re+cu} \bullet MB \equiv mm \bullet MB$$

where we have defined mm as the money multiplier.

Now we can see formally how the desire to hold some currency decreases the ultimate expansion of M1. Barro (p. 47) argues $cu = .4$, which implies the \$1 million open market purchase leads

to a $\frac{1.4}{.52} = \$2.69$ million increase in M1.

Open Market Operations (OMO) can take the form of:

(a) outright purchases and sales of securities (long term injections and withdrawals)

(b) repurchase agreements (purchases) and matched sale-purchase agreements (sales-just a reverse repo)

These are short term injections and withdrawals of reserves.

D. OVERNIGHT FED FUNDS RATES[8]

Overnight markets[9] in Fed Funds and RPs play an important role in helping commercial banks meet their reserve obligations to the Fed.

The supply and demand for Fed Funds (just CBR) arise as a means of efficiently distributing reserves throughout the banking system. The Monetary Control Act of 1980 restricts participation in the market only to commercial banks, savings and loans, and credit unions.

At any given time, individual banks may be above or below their desired reserve positions. For example, since the nation's largest corporations tend to concentrate their short term borrowing in NY, NY banks are often short on reserves and can borrow in the Fed Funds market. On the other hand, many smaller banks receive more deposits than they can lend locally. Since reserves earn no interest, banks with excess reserves can lend them in the Fed Funds Market.

Borrowing and Lending in the Fed Funds Market determine the Fed Funds interest rate. Below is a simple model of the determination of the Fed Funds rate. It is based on an expanded view of bank balance sheets.

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[8]This section draws heavily on M. Goodfriend and W. Whelpley (1993) "Federal Funds" in Instruments of the Money Market, T. Cook and R. LaRoche, eds., Federal Reserve Bank of Richmond, p. 7-21.

[9]Note: This is not an organized exchange like the Stock Market, Commodities Market, etc. It is a "telephone market."

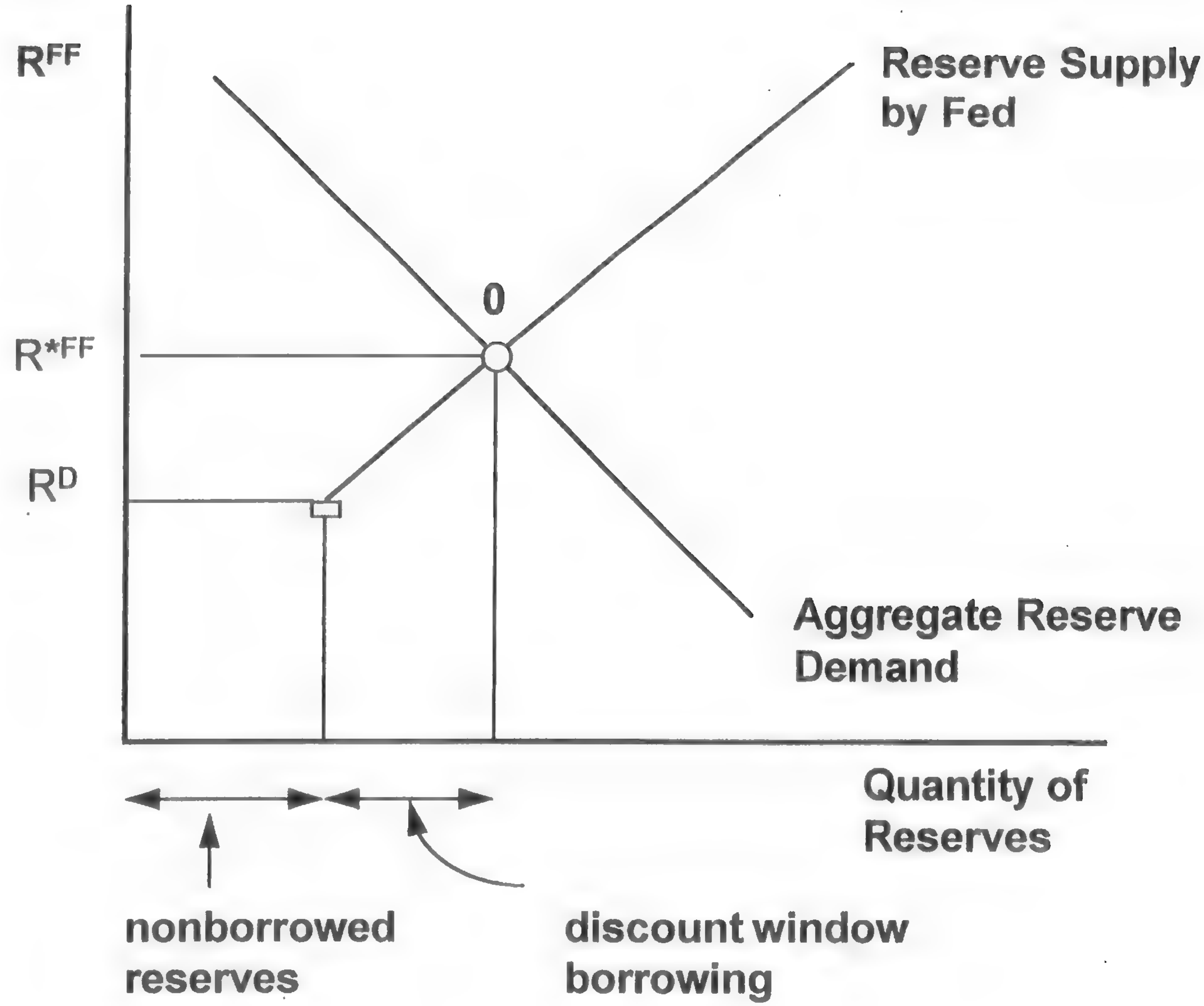


Figure VII.1 Fed Funds Market

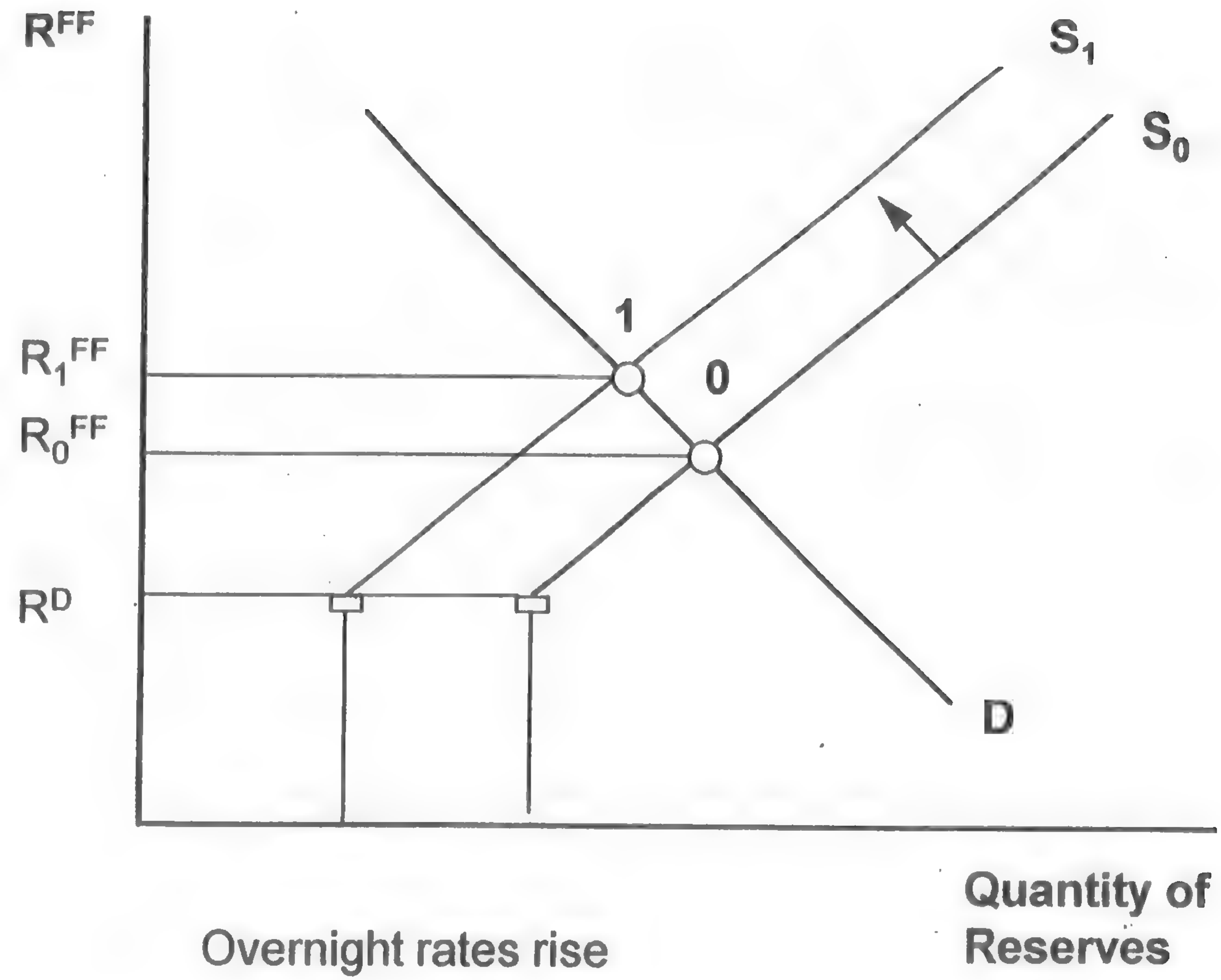


Figure VII.2 OMO: Matched Sale-Purchase Agreement

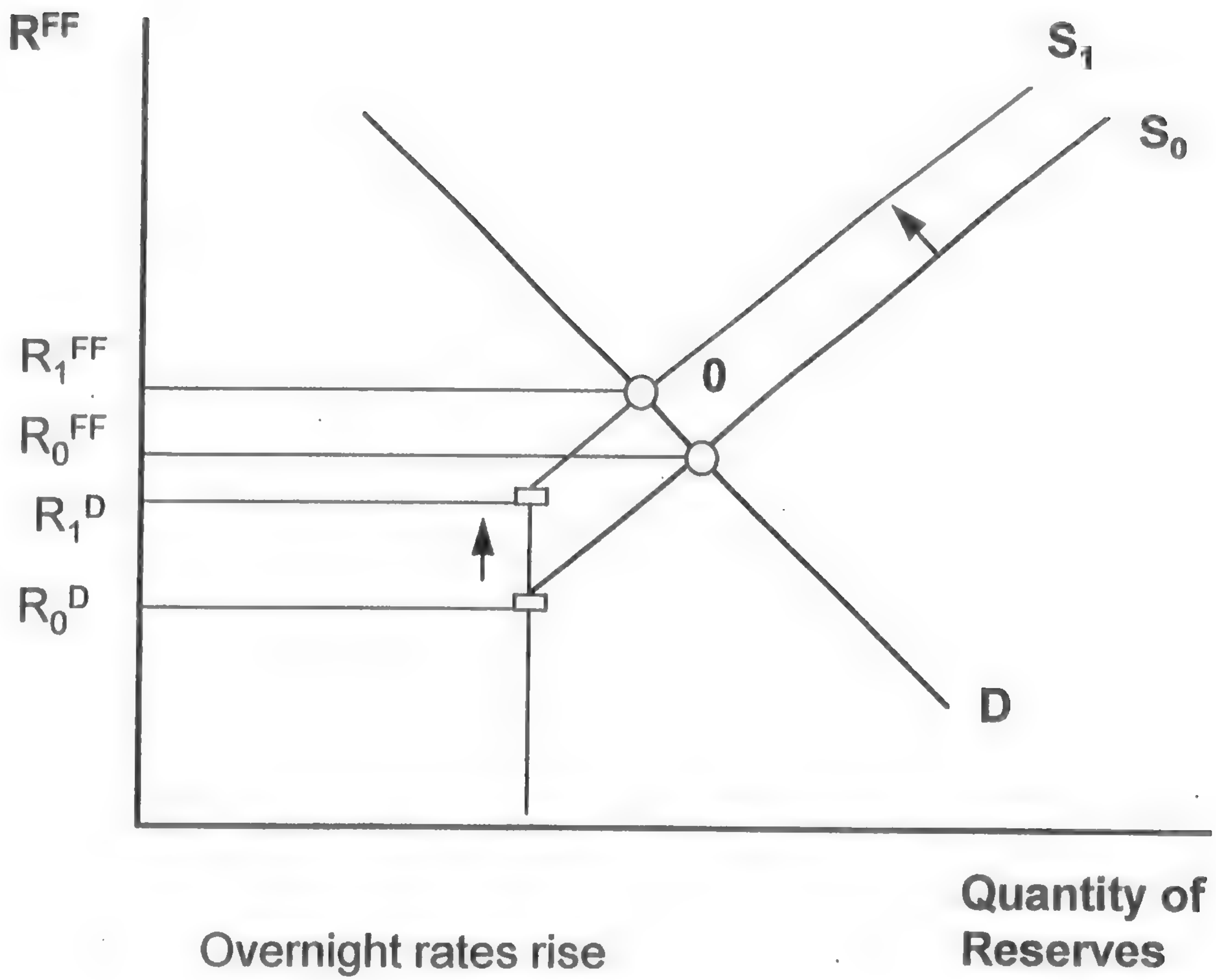


Figure VII.3 Discount Rate Policy

Fed Balance Sheet

A	L
Govt securities	Currency
Foreign XΔ	CBR (non-borrowed)
CBR (borrowed at discount window)	

Comm. Bank Balance Sheet

A	L
Govt securities	Checkable Deposits
CBR (non-borrowed)	CBR (borrowed at discount window)
*Fed Funds loaned	Fed Funds borrowed*

*Note: This was the balance sheet for a particular bank so it could have non-offsetting entries in Fed Funds loans and borrowings. On a consolidated Commercial Bank balance sheet, these two would offset. See Figure VII.1.

To generate the market for Overnight Reserves (the Fed Funds market) we need to study demand and supply. The aggregate *demand* for bank reserves arises from the public's demand for checkable deposits. Since checkable deposits fall as interest rates rise, so too do reserve holdings by commercial banks. The *supply* of reserves by the Fed are broken down into 2 parts: nonborrowed and borrowed. *Nonborrowed reserves* as those augmented or depleted by OMO. *Borrowed reserves* are those acquired by Commercial Banks at the Fed Discount Window at interest rate R^D. The higher is the Fed Funds rate R^{FF} relative to the discount window rate R^D, the more incentive banks have to borrow from the Fed.

Now we will do a couple of experiments. First, suppose the Fed conducts a matched sale-purchase agreement in the Fed Funds market (i.e. sells securities with a short term commitment to repurchase). What happens to the Fed Funds Rate? See Figure VII.2.

What if the Fed raises the discount rate? See Figure VII.3.

Can the Fed peg the Fed Funds rate? For example, suppose there's a temporary aggregate increase in checkable deposits (e.g. a seasonal at Christmas), in which case reserve demand would rise. To offset the excess demand for reserves, the Fed could write a series of RPs (purchasing securities) thereby raising nonborrowed CBR. See Figure VII.4.

As a final note, the RP market is closely tied to the Fed Funds market. The RP market has many more participants (e.g. corporations, life insurance companies, mutual funds, etc.) who are not excluded by law. The RP interest rate lies below the Fed Funds rate because RPs are collateralized, while Fed Funds are not. If R^{FF} was excessively higher than R^{RP}, banks would simply borrow in that market. See Figure VII.5.

Review: How does the Fed Generate Money Supply Growth?

Ans: Either through outright purchases or a series of repos, the Fed buys securities of commercial banks and money market dealers, paying for the securities with CB reserves or currency. This increases the monetary base, which ultimately leads to an increase in M1 via the multiplier effect (i.e. $\Delta M1 = mm \cdot \Delta MB$)

E. SUMMARY

This chapter studies the money supply process and the implications of money supply growth for inflation. Our focus on M1 isolates two important actors in the money supply process: the Fed and commercial banks.

The primary instrument employed by the Fed to increase M1 is open market operations. An open market purchase of government securites (whether outright or via repurchase agreements) adds to the reserves of commercial banks. Since commercial bank reserves do not earn interest, banks will lend their excess reserves out. Ultimately, the funds generated by the loan end up in the hands of someone (e.g. a car loan is ultimately deposited at the car dealer's bank). But this generates reserves for the car dealer's bank, which will be loaned out after required reserves are set aside by the bank. Since reserve requirements drain off some of the banks ability to loan, this process ultimately dies out. However, at each stage of the process checkable deposits were created. Since M1 is nothing other than currency and checkable deposits, the ultimate expansion of the money stock was a multiple of the initial injection of reserves. This process is called the money multiplier.

We also studied the overnight market in reserves or Fed Funds. This market exists to efficiently funnel reserves from banks which have excess reserves to banks with insufficient reserves. Obviously the Fed, being the commercial banks' bank, has virtual monopoly power

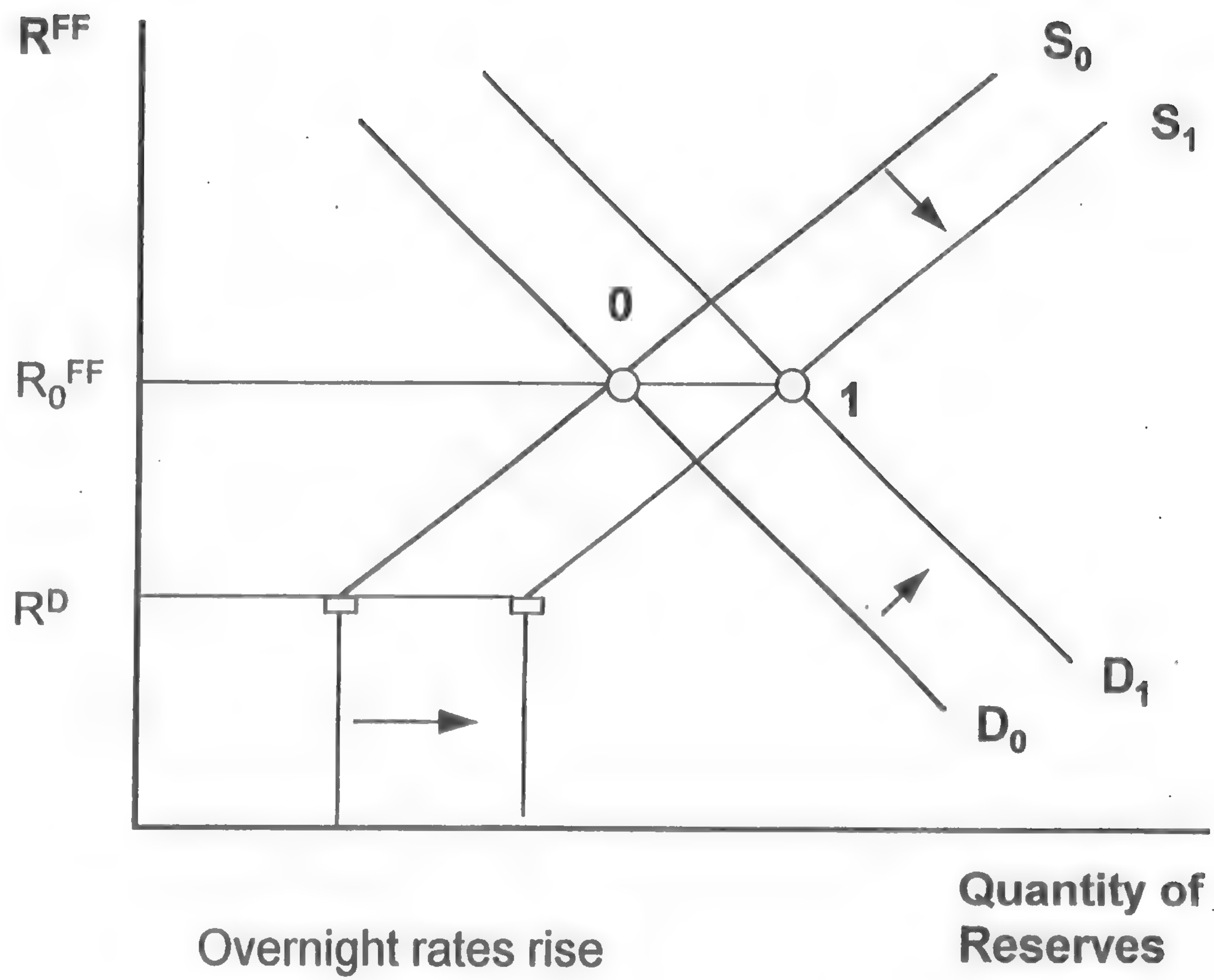


Figure VII.4 Peg the Fed Funds Rate

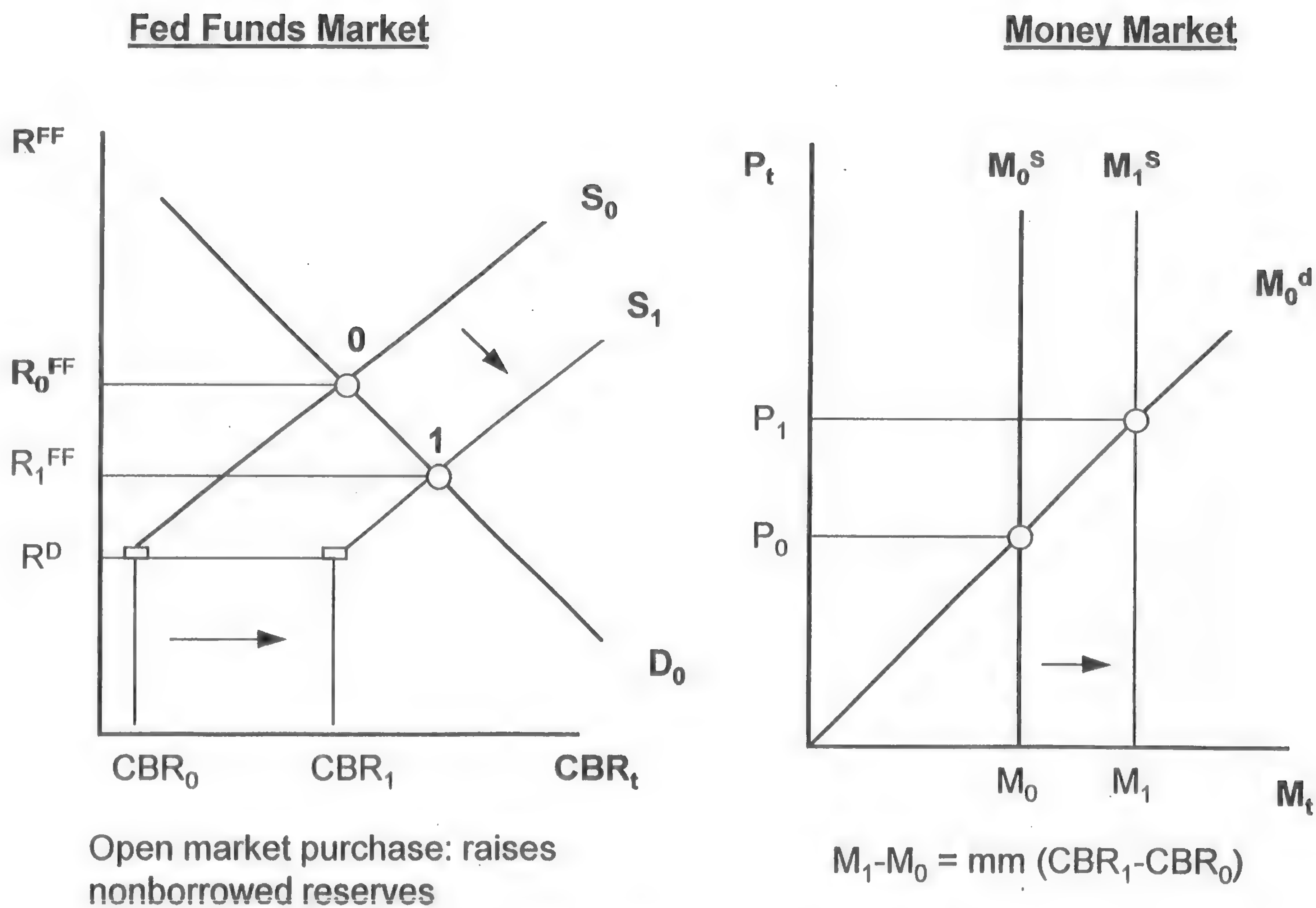


Figure VII.5 Money Supply Growth

in this market. Through its influence on the supply of reserves and its discount window policy, it can influence the price in that market (i.e. the Fed Funds rate). We saw how, for example, an overnight open market sale of government securities (matched sale-purchase agreement) can raise the Fed Funds rate (which is the way the Fed influenced the Funds rate during the recent "tight" Fed policy actions).

Chapter VIII

ASSET PRICING

To keep things simple in the previous chapters, we assumed there was no uncertainty. Obviously, there is alot of uncertainty about future economic conditions in the real world. This uncertainty has important implications for asset pricing. In this chapter, we study the role of expectations and aversion to risk in the general pricing of assets.

A. THE ROLE OF EXPECTATIONS

In the previous chapters, we saw how the demand and supply of bonds influenced the real interest rate and vice versa (that is, that the real interest rate influenced the demand and supply of bonds). The problem with the analysis of the previous chapters is that individuals don't know the real interest rate when making their borrowing or lending decisions. Even though the number of dollars received at t+1 in exchange for a good at t is known (and can be found in the Wall Street Journal, i.e. $(1+R_t)P_t$) at time t, the number of goods received in the future (i.e. $(1+R_t)P_t/P_{t+1}$) cannot be found in Wall Street Journal since P_{t+1} is not known at time t.

In this case we have to form an expectation about P_{t+1} conditional on our current (time t) information. We write this forecast as $E[P_{t+1} \mid \Im_t]$ where $\Im_t$ denotes information at t. An agent can *expect* to receive $\dfrac{(1+R_t)}{1+\Pi_t^e}$ or $1+r_t^e$ units of future goods, where superscript e denotes expected inflation or expected real interest rates. By definition then, $R_t = r_t^e + \Pi_t^e$. The relevant return when making savings decision is obviously r_t^e because r_t is only known after the fact (or ex-post).

What happens when actual inflation does not equal expected inflation (i.e.$\Pi^e \neq \Pi$)? Obviously, it can't always be the case that what you expect actually happens. See Figure VIII.1. During the two oil price shocks there were sustained differences in Π_t and Π_t^e. The more important question is, Do you make systematic mistakes? In that case you should learn from your systematic mistakes, which would lower your losses.

What if $\Pi_t > \Pi_t^e$? Since R_t was contracted to on the basis of Π_t^e, then the real return to lending r_t will be lower than what you anticipated. This results in a transfer from lenders to borrowers. See Figure VIII.2, where inflation surprises are graphed alongside ex-post real interest rates. Note that as suggested above, unanticipated inflation occurs alongside low (even negative) real rates.

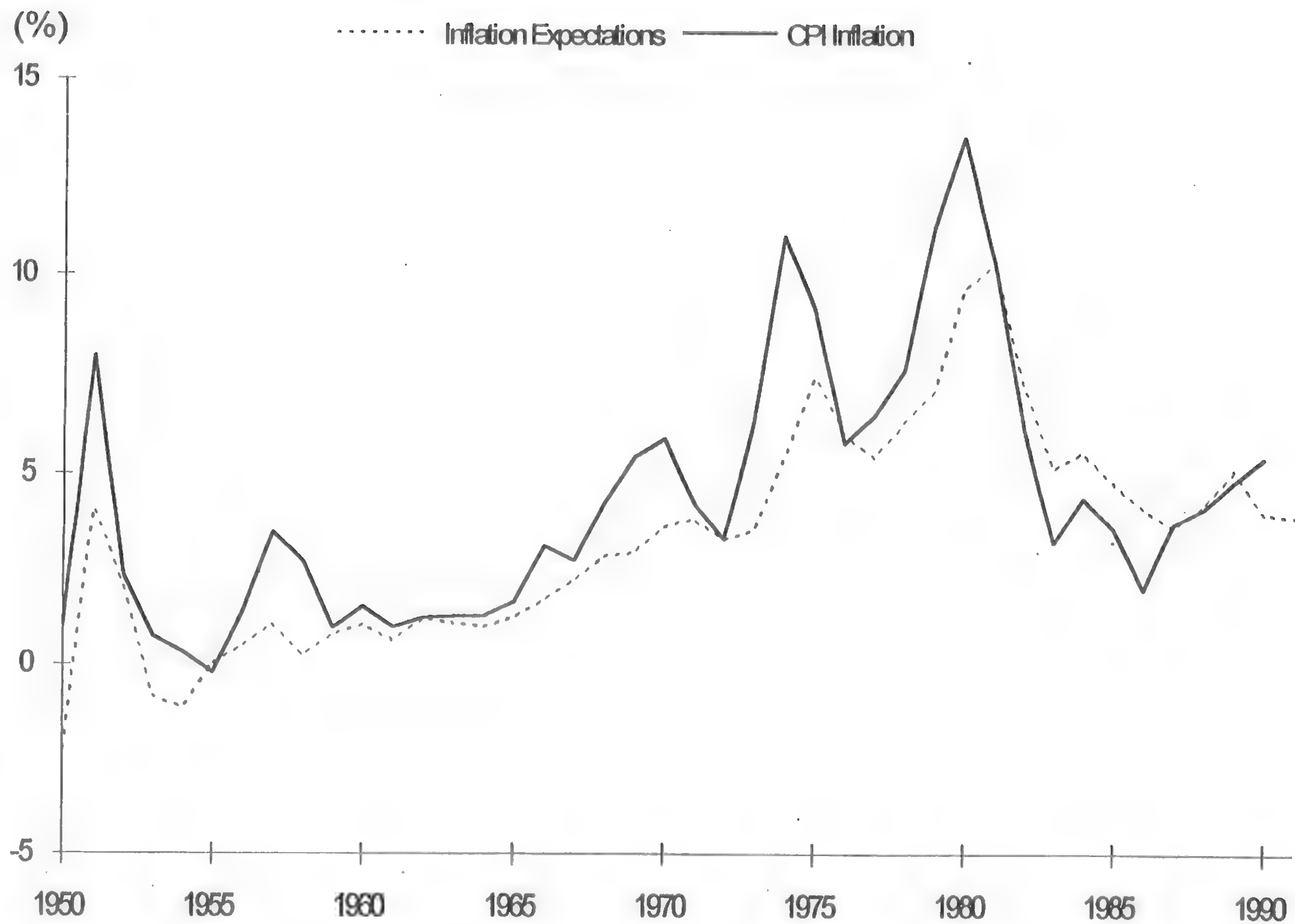


Figure VIII.1 Inflation vs Inflation Expectations (Livingston Survey)

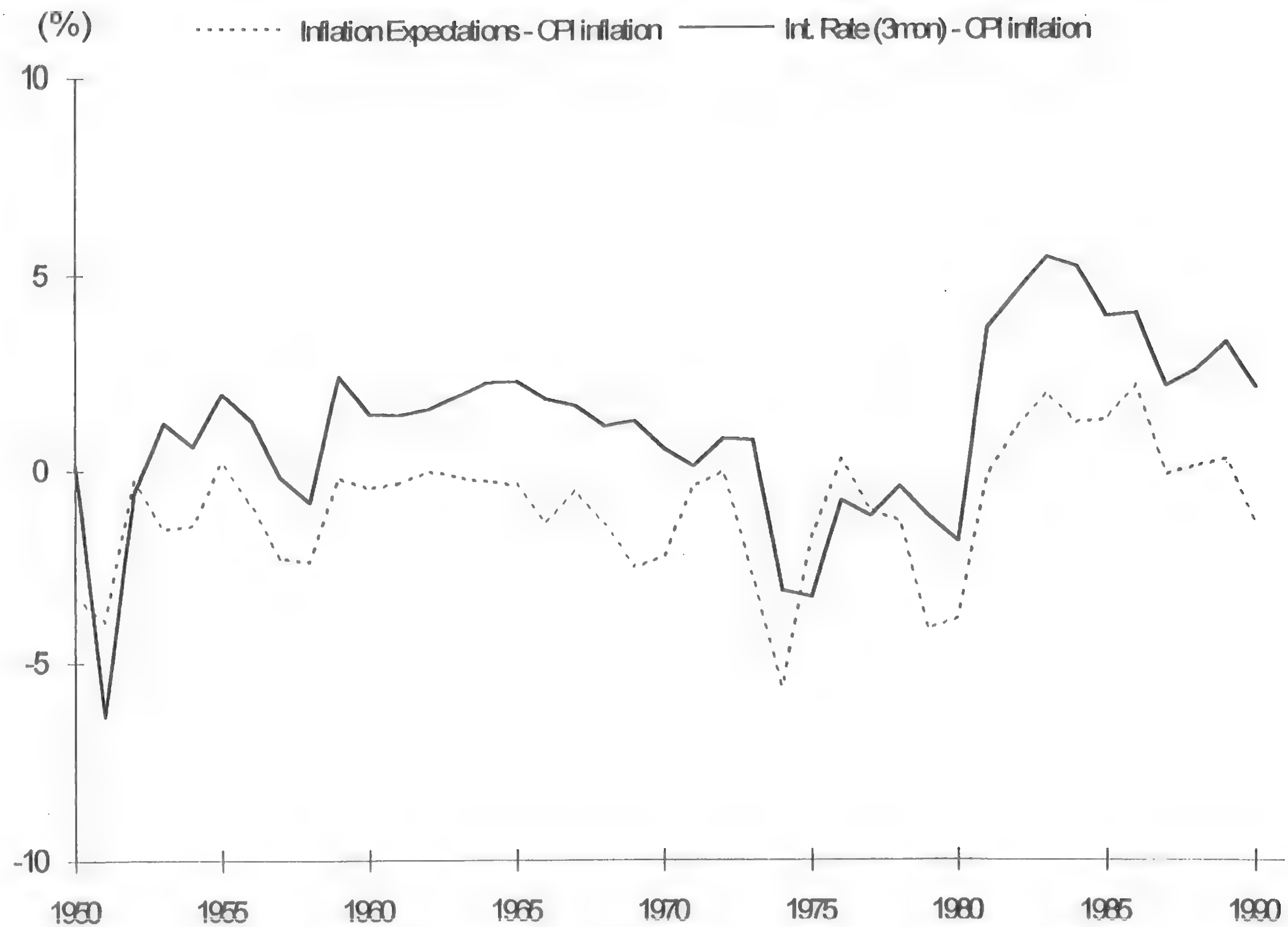


Figure VIII.2 Inflation Surprises and Real Interest Rates

B. THE TERM STRUCTURE OF INTEREST RATES

The term structure of interest rates is the yield on bonds of similar risk but different maturities (e.g. 1,2,3,6 month interest rates on T-Bills and 1,2,3,5,7,10,15, and 30 year Treasury bonds. See Figure VIII.3 for a plot of the 10 year bond against the 3 month T-bill.

Why do long rates sometimes exceed short rates and at other times we find the opposite? For simplicity, lets think of a long term bond as spanning 2 periods (and denote the per period nominal return R_t^L) and a short term bond as spanning only 1 period (and denote the per period nominal return R_t^S). Suppose that a saver does not care about risk (we call these individuals risk neutral) and has no need for short term liquidity. Then consider the following two saving strategies:

(a) purchase a short term bond at t and when it matures at t+1, roll it over into another short term bond. The expected return from the strategy is $(1+R_t^S)(1+R_{t+1}^{Se})$.

(b) purchase a long term bond at t. The return from this strategy is $(1+R_t^L)^2$.

What if $(1+R_t^S)(1+R_{t+1}^{Se}) > (1+R_t^L)^2$. Then strategy (a) dominates strategy (b). No savers would want to hold the long bond (i.e. the demand for long bonds would fall) and the resulting excess supply would lower the long bond price or raise the return R_t^L until equality would be restored.

What if $(1+R_t^S)(1+R_{t+1}^{Se}) < (1+R_t^L)^2$. Then strategy (b) dominates strategy (a). Savers would want to hold the long bond (i.e. the demand for long bonds would rise) and the resulting excess demand would raise the long bond price or lower the return R_t^L until equality would be restored.

Thus, by arbitrage we know →

$$(1+R_t^L)^2 = (1+R_t^S)(1+R_{t+1}^{Se})$$

This relation is known as the **Expectations Hypothesis** of the term structure. An approximation to the above formula is[10]:

[10] Using the following simple math fact that the logarithm of 1+x is approximately x when x is a small number, we can take logs of both sides of the above equation to yield the simplified approximate expression.

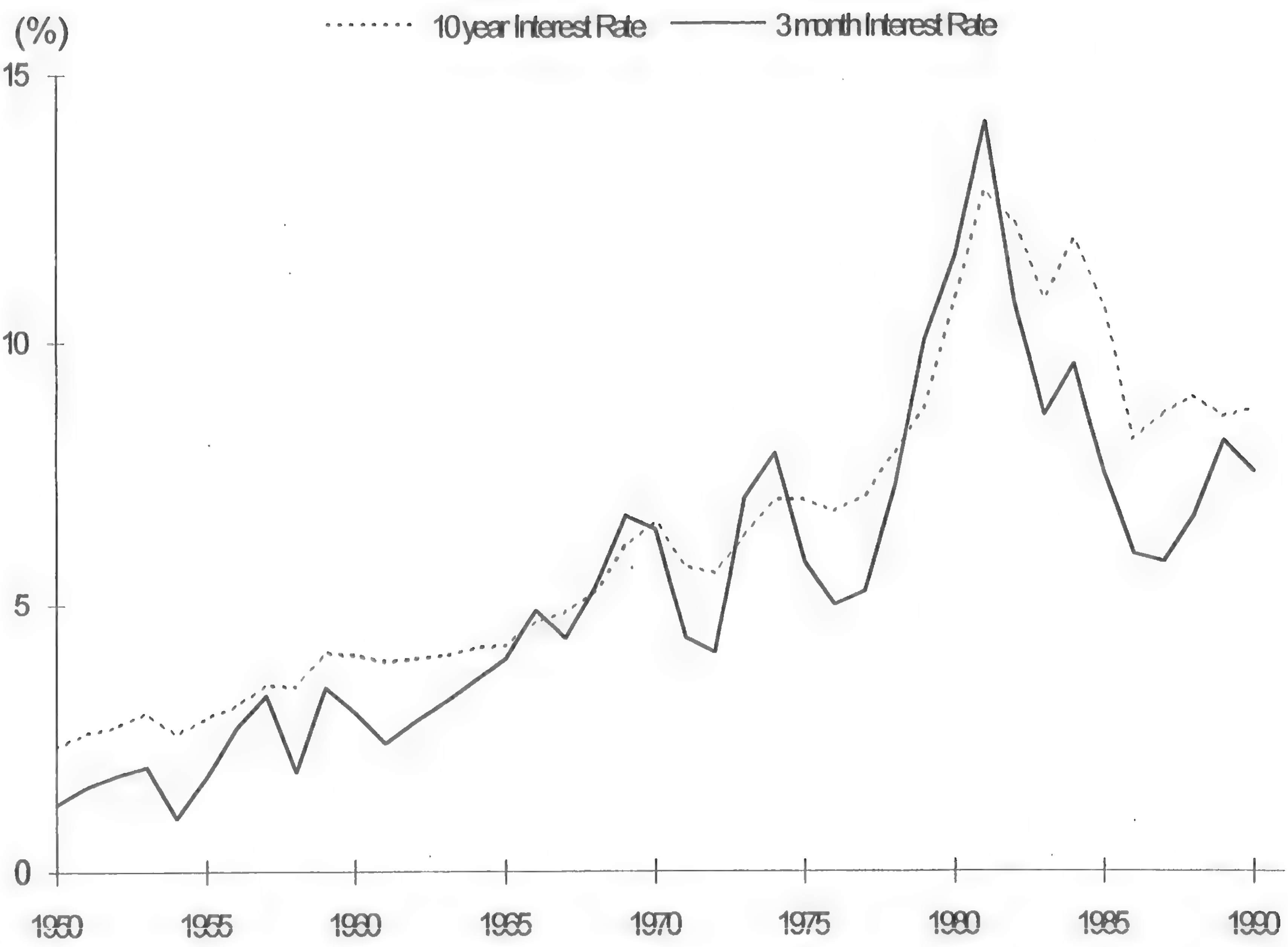


Figure VIII.3 Long and Short Interest Rates

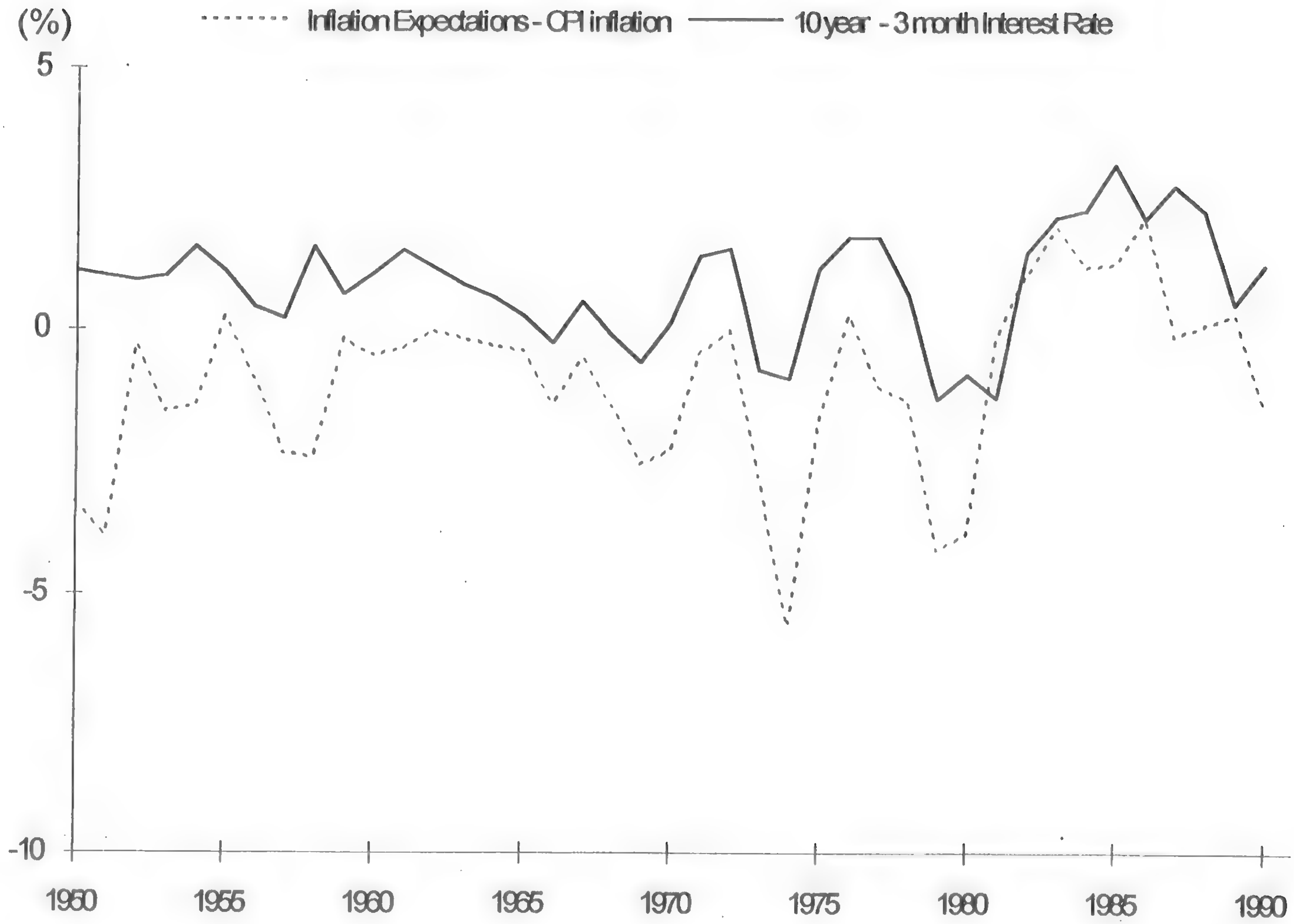


Figure VIII.4 Inflation Surprises and the Term Structure

$$R_t^L = \frac{R_t^S + R_{t+1}^{Se}}{2}$$

That is, the long rate is just the average of 2 short rates.

The expectations hypothesis predicts that periods in which nominal short rates exceed nominal long rates ($R_t^S > R_t^L$) occur when future short rates are expected to fall ($R_t^S > R_{t+1}^{Se}$). Similarly, periods in which long rates exceed short rates ($R_t^S < R_t^L$) occur when future short rates are expected to rise ($R_t^S < R_{t+1}^{Se}$).

Once we grasp the connection between money supply growth and inflation, we can begin to understand the relation between money supply growth and nominal interest rates (in particular long run rates). Rewriting the short nominal rate into its decomposition of real rate and inflation, we have:

$$R_t^L = \frac{r_t^{Se} + \Pi_t^e + r_{t+1}^{Se} + \Pi_{t+1}^e}{2}$$

That is, the long rate is just the average of the current and future short term expected real interest rate as well as the average of the current and future expected inflation rates. Now you should understand why the Fed is interested in long term nominal interest rates and the term structure. From the term structure the Fed can use the bond market to obtain assessments of expectations about future inflation Π_{t+1}^e. The Fed can also influence the term structure through monetary policy; if people believe that money growth in the future will be low, then their inflation expectations will be low, and long term nominal interest rates can be low.

As in the previous section on short term rates, inflation surprises can have important implications for the term structure. For example, Figure VIII.4 suggests that if people are surprised by inflation (say $\Pi_t > \Pi_t^e$), they believe the excessive inflation is temporary. In this way, when $\Pi_t^e - \Pi_t < 0$, $R_t^{10} - R_t^3$ is negative.

C. MORE GENERAL ASSET PRICING RELATIONS

It is easy to generalize the framework we have been working with to "price" many different types of assets, including stocks.

First, we need to talk about preferences. We represent an agent's preferences over consumption today and tomorrow as:

$$U(C_t,C_{t+1}) \equiv U(C_t) + \frac{1}{1+\rho} E[U(C_{t+1}) | I_t]$$

where $1/1+\rho$ is the agent's discount factor (i.e. if $\rho > 0$ the agent prefers consumption today more than consumption tomorrow).

We will use preferences to characterize two different types of saver's attitudes towards risk. A **risk neutral** saver is indifferent between a sure bet and a gamble that yields the same expected payoff. A **risk averse** saver prefers the sure bet to the gamble.

Case 1: Risk Neutral Agents

Represented by a linear utility function: $U(C_t) = kC_t$. See Figure VIII.5.

Case 2: Risk Averse Agents

Can be represented by a logarithmic utility function $U(C_t) = \log_e C_t$. See Figure VIII.6.

Next we need to think about budget constraints. We can introduce many different assets into the agent's single period budget constraint:

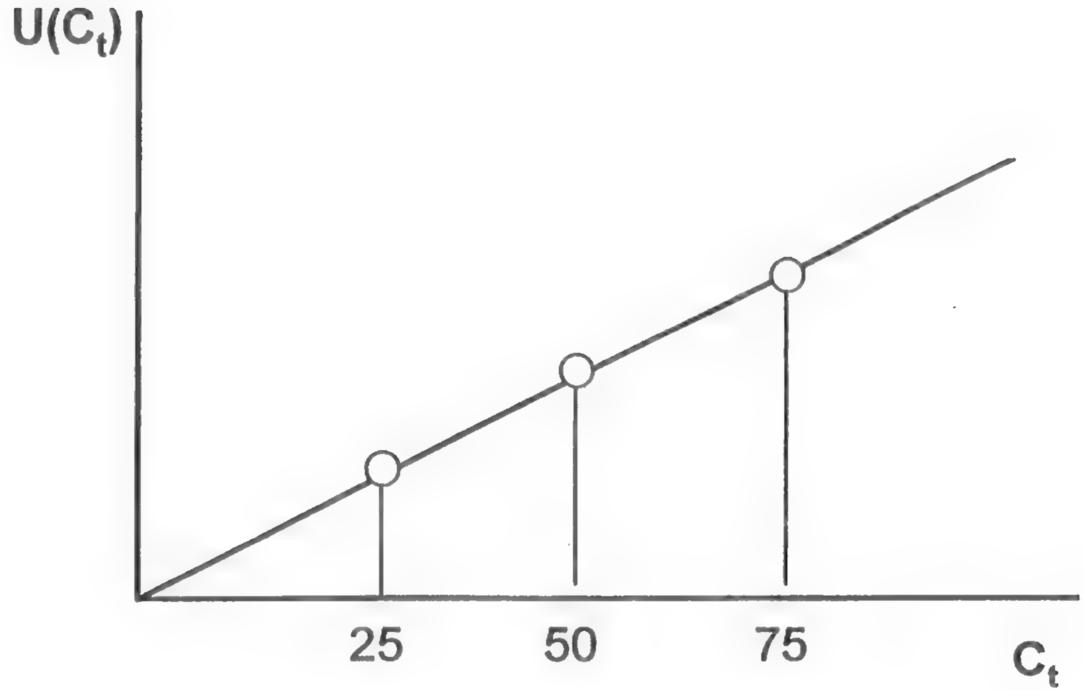
$$P_tC_t + Q_t^BB_t + Q_t^sS_t + M_t = P_tY_t + B_{t-1} + (Q_t^s+d_t)S_{t-1} + M_t$$

where Q_t^B $\equiv$ dollar price of one-period discount bonds (i.e. the nominal price at t of a bond which pays \$1 at t+1).
Q_s^t $\equiv$ dollar price of a stock
B_t,S_t $\equiv$ bond and stock holdings
d_t $\equiv$ nominal dividend on stock

Later we'll even introduce foreign currencies and forward contracts.

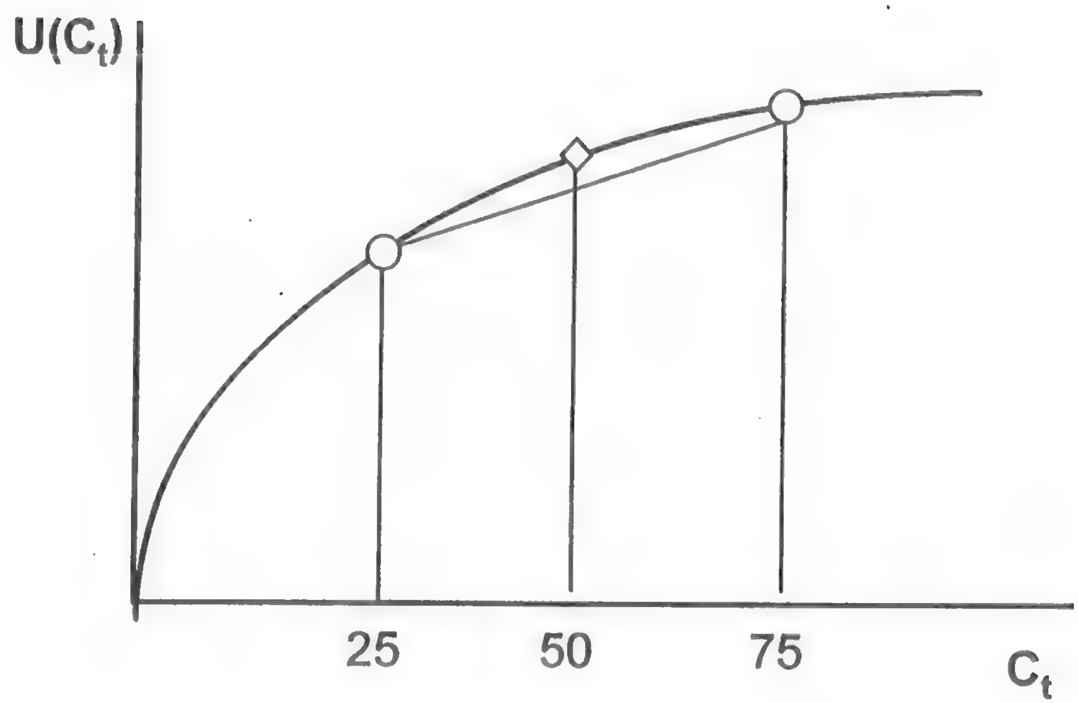
C.1 PRICING BONDS

Suppose an individual postpones consumption today (t) and buys a discount bond in order to consume more tomorrow (t+1). That is, they take Q_t^B dollar and purchase a discount bond.



- Receive 50 for sure utility = k 50
- Receive 25 or 75 with a coin flip
  = (1/2) k 25 + (1/2) k 75 = k 50

Figure VIII.5 Risk Neutral Agents



- Receive 50 for sure utility = 3.91
- Receive 25 or 75 with a coin flip
  = (1/2) 3.22 + (1/2) 4.32 = 3.77

Figure VIII.6 Risk Averse Agents

That means $\frac{Q_t^B}{P_t}$ less goods today, which means $\frac{Q_t^B}{P_t}\Delta U(C_t)$ less utility today. This can be considered the marginal utility loss or cost of purchasing a bond.

At t+1, the bond pays \$1. That buys, $1/P_{t+1}$ goods which generates $\frac{1}{1+\rho}E\left[\frac{\Delta U(C_{t+1})}{P_{t+1}} \mid \Im_t\right]$ more expected present discounted utility. This can be considered the marginal utility gain or benefit of purchasing a bond.

Setting marginal cost = marginal benefit we have:

$$Q_t^B = \frac{1}{1+\rho} E\left[\frac{\Delta U(C_{t+1})}{\Delta U(C_t)} \bullet \frac{P_t}{P_{t+1}} \mid \Im_t\right]$$

<u>Case 1: Risk Neutral Agents</u>

In this case, $\Delta U(C_t)=k$, and the bond pricing equation simplifies to:

$$Q_t^B = \frac{1}{1+\rho} E\left[\frac{k}{k} \bullet \frac{1}{1+\Pi_t} \mid \Im_t\right]$$

Does this bond pricing equation make sense? First, let's restate the bond market diagram in terms of prices rather than returns (this, in essence, simply inverts the old diagram). See Figure VIII.7. An increase in impatience makes people want to borrow more (i.e. supply more bonds), in which case excess supply lowers bond prices. An increase in expected inflation makes the returns from holding dollar denominated bonds less valuable, reducing the motivation to save (i.e. demand less bonds). The resulting excess supply again lowers price.

To relate these bond pricing results back to interest rates, recall that bond prices and returns are inversely related. In this case we have our old relation among nominal interest rates and inflation (neglecting something called Jensen's inequality):

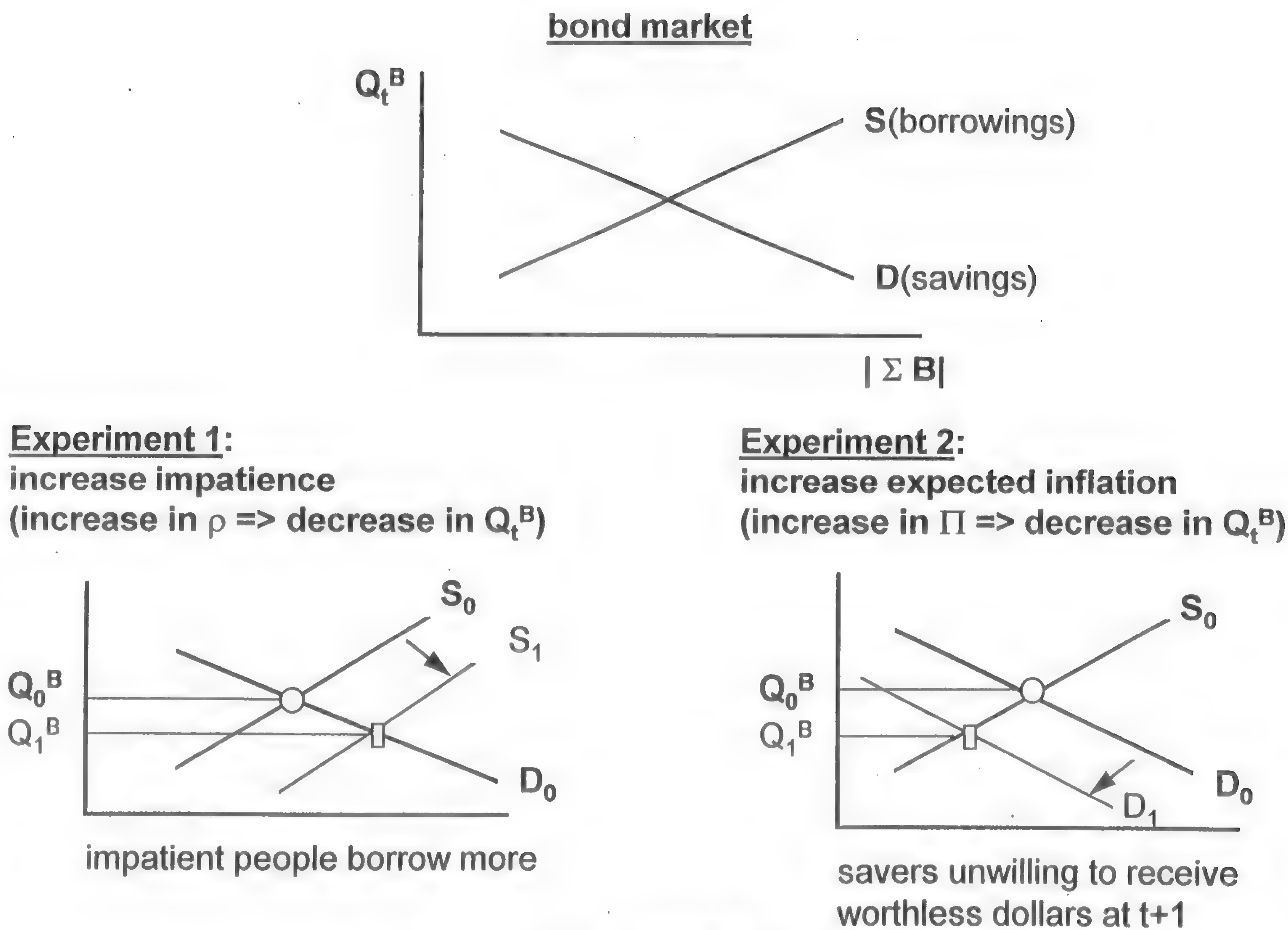


Figure VIII.7 Pricing Bonds

$$1+R_t = (1+\rho)(1+\Pi_t^e)$$

This relation shows how preferences affect nominal interest rates. That is, the real interest rate is related to individuals impatience ($r_t=\rho$).

Case 2: Risk Averse Agents

In this case $\Delta U(C_t) = 1/C_t$. This implies $\dfrac{\Delta U(C_{t+1})}{\Delta U(C_t)} = \dfrac{C_t}{C_{t+1}} = \dfrac{Y_t}{Y_{t+1}}$ (via goods market clearing where demand = supply). Let's define the growth rate of real GNP as g_t (i.e. $Y_{t+1} = (1+g_t)\,Y_t$). Then $\dfrac{Y_t}{Y_{t+1}} = \dfrac{1}{1+g_t}$.

Then the bond price is

$$Q_t^B = \frac{1}{1+\rho}\,E\left[\frac{1}{1+g_t}\bullet\frac{1}{1+\Pi_t}\mid \mathfrak{I}_t\right]$$

Recall that g_t and Π_t are random since Y_{t+1} and P_{t+1} are unknown at time t.

Math Fact: The expectation of the product of two random variables is just the product of the expectations and the covariance of those two variables. That is,

$$E[X \bullet Z] = E[X] \bullet E[Z] + COV(X,Z)$$

Using the math fact, we can express bond prices as:

$$Q_t^B = \frac{1}{1+p}\left\{E\left[\frac{1}{1+g_t}\middle|\mathfrak{I}_t\right]\bullet E\left[\frac{1}{1+\Pi_t}\middle|\mathfrak{I}_t\right] + COV\left[\frac{1}{1+g_t}\bullet\frac{1}{1+\Pi_t}\middle|\mathfrak{I}_t\right]\right\}$$

("inflation risk premium")

So the old inverse relation between bond prices and impatience or expected inflation still holds. But now we see other determinants of bond prices. In particular, we see how expectations of

boom (high g) or recession (low g) affect bond prices (i.e. we see how technology affects bond market conditions). For instance, ↑g (i.e. expect a boom next period relative to today) → ↓ Q^B_t.

Question: What if we expect a boom next period (i.e. ↑g)?

Answer: ↓ Q^B_t. Why? If output is expected to be high in the future relative to today, people would want to borrow against that future growth. Then the supply of bonds increases. Excess supply puts downward pressure on price. See Figure VIII.8.

Question: How does risk influence price?

Ans: Depends on the covariance between output growth and inflation. Suppose prices are high just when the economy is in a recession (i.e. ↑Π, ↓g → cov < 0). Then Q^B_t decreases. Why? Your future cash from investing in the bond is not worth many goods just when you need goods the most. In that case the asset isn't a great hedge against the risk associated with inflation, so you demand less of it. See Figure VIII.9.

C.2 PRICING STOCKS

Suppose an individual postpones consumption today (t) and buys a stock in order to consume more tomorrow (t+1). That is, they take Q^s_t dollars and purchase some stock. That means $\frac{Q^s_t}{P_t}$ less goods, which in turn means $\frac{Q^s_t}{P_t} \Delta U(C_t)$ less utility. This can be considered the marginal utility loss or cost of purchasing a stock.

At t+1, the stock pays $Q^s_{t+1} + d_{t+1}$. That buys $\frac{Q^s_{t+1} + d_{t+1}}{P_{t+1}}$ goods which generates

$$\frac{1}{1+\rho} E \left[\frac{\Delta U(C_{t+1}) \, (Q^s_{t+1} + d_{t+1})}{P_{t+1}} \mid \mathfrak{I}_t \right]$$

more expected present discounted utility. This can be considered the marginal utility gain or benefit of purchasing a stock.

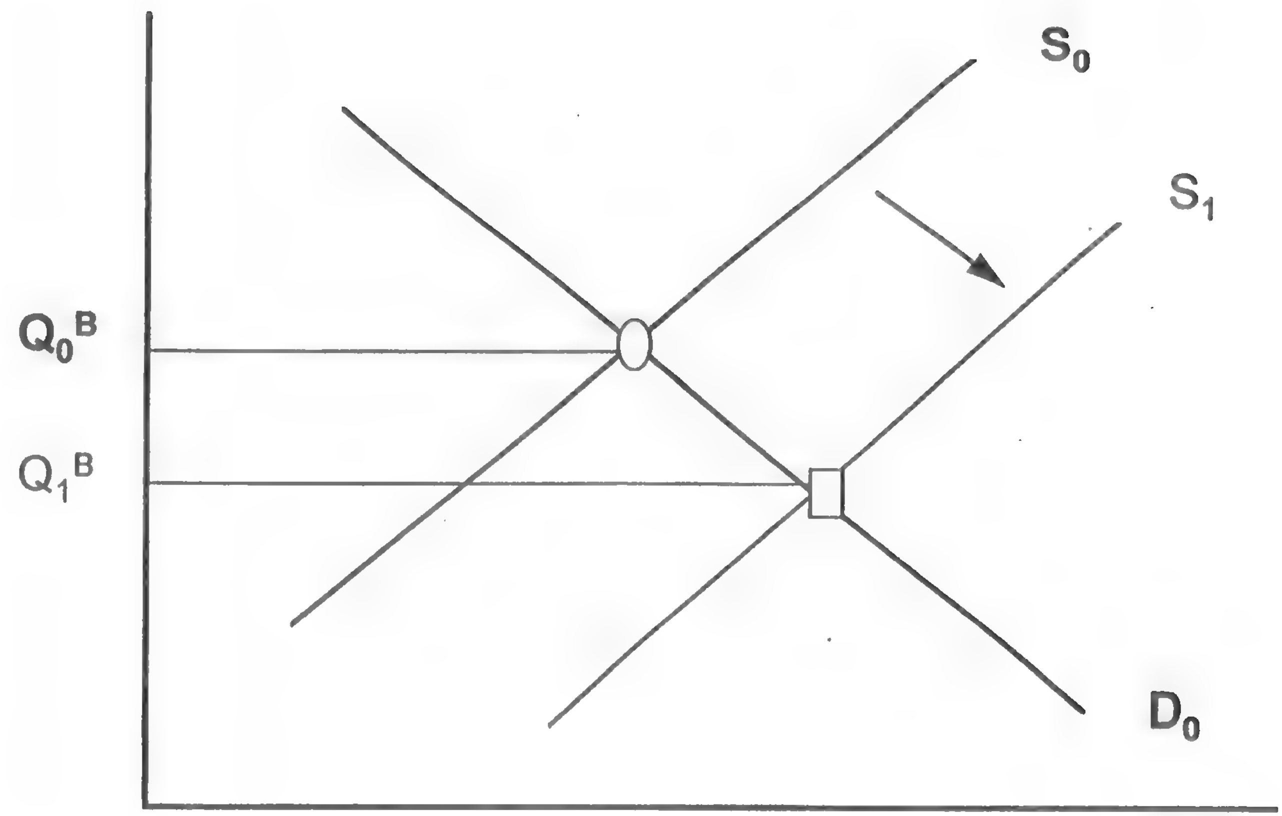


Figure VIII.8 Bond Prices: Boom Next Period

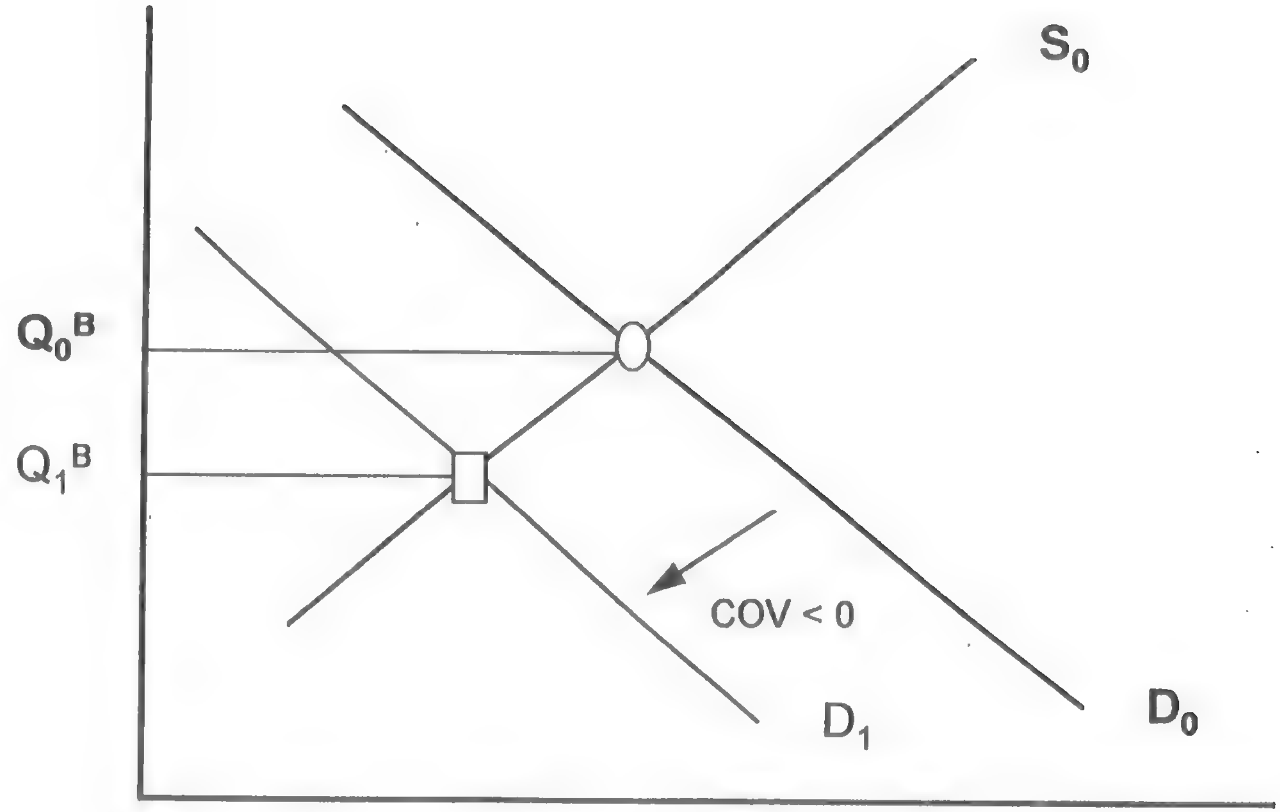


Figure VIII.9 Bond Prices: Effect of Risk

Setting marginal cost = marginal benefit, and defining prices in terms of goods rather than money, we have:

$$q_t^s = \frac{1}{1+p} E\left[\frac{\Delta U(C_{t+1})(q_{t+1}^s + \partial_{t+1})}{\Delta U(C_t)} \mid \Im_t\right]$$

where $q_t^s \equiv \frac{Q_t^s}{P_t}$ $\equiv$ "real" price of stock

$$\partial_t \equiv \frac{d_t}{P_t} \equiv \text{real dividend}$$

Case 1: Risk Neutral Agents

$$q_t^s = \frac{1}{1+\rho} E\left[q_{t+1}^s + \partial_{t+1} \mid \Im_t\right]$$

If we continued to substitute out future prices, this formula states that the real stock price is just the expected present discounted value of future real dividends. That is:

$$q_t^s = E\left[\sum_{j=1}^{\infty} \left[\frac{1}{1+\rho}\right]^j \partial_{t+j} \mid \Im_t\right]$$

Case 2: Risk Averse Agents

$$q_t^s = \frac{1}{1+\rho} E\left[\frac{1}{1+g_t} \bullet \left(q_{t+1}^s + \partial_{t+1}\right) \mid \Im_t\right]$$

Using our math fact we have

$$q_t^s = \frac{1}{1+\rho}\left\{ E\left[\frac{1}{1+g_t}\,\middle|\,\Im_t\right] \bullet E\left[q_{t+1}^s + \partial_{t+1}\,\middle|\,\Im_t\right] + \underbrace{COV\left[\frac{1}{1+g_t},\ q_{t+1}^s + \partial_{t+1}\,\middle|\,\Im_t\right]}_{\text{risk premium on stocks}}\right\}.$$

This relation suggests that expectations about the state of the economy influence stock prices in offsetting ways. On the one hand, an increase in expected future prices (important for capital gains) or expected future real dividends will raise the demand for stocks and hence raise prices today. On the other hand, perceptions of a future boom may entice agents to consume more today dissaving through sales of stocks or decreased demand. See Figure VIII.10.

What role does the risk premium play? The answer depends on the covariance between output growth and future payouts. Suppose the future sale price of the stock or future dividends are high just when the economy is perceived to go into a recession (i.e. $\downarrow g$, $\uparrow(q_{t+1}^s + \partial_{t+1})$ This results in a positive cov_t. In that case the stock is a great hedge against risk and its demand will be high. This results in a higher current price. On the other hand, suppose future sale price or dividends are low just when the economy is perceived to go in a recession (i.e. $\downarrow g$, $\downarrow(q_{t+1}^s + \partial_{t+1})$). This results in a negative covariance. In that case the stock is a poor hedge against risk and its demand will be low. This results in a lower current price or higher return necessary to compensate for the risk. See Figure VIII.11.

C.3 ON THE RELATION BETWEEN CAPM & CCAPM

The results on risk premia that I have derived should (I hope!) be as intuitive as the relation between risk and return in the CAPM, the standard pricing formula in introductory finance classes.

Pricing Particular Stocks

In the CAPM framework, a particular stock that has a high return just when the market has a high return, doesn't provide much hedge against risk when the market turns sour (i.e. it will have a low return when the market hits lows. This high β stock must be associated with a high return in order to compensate the investor for the risk. On the other hand, a stock that doesn't follow the ups and downs of the market in general provides a good hedge against risk when the market turns sour. This low β stock will be associated with a low return since it offers another service - insurance.

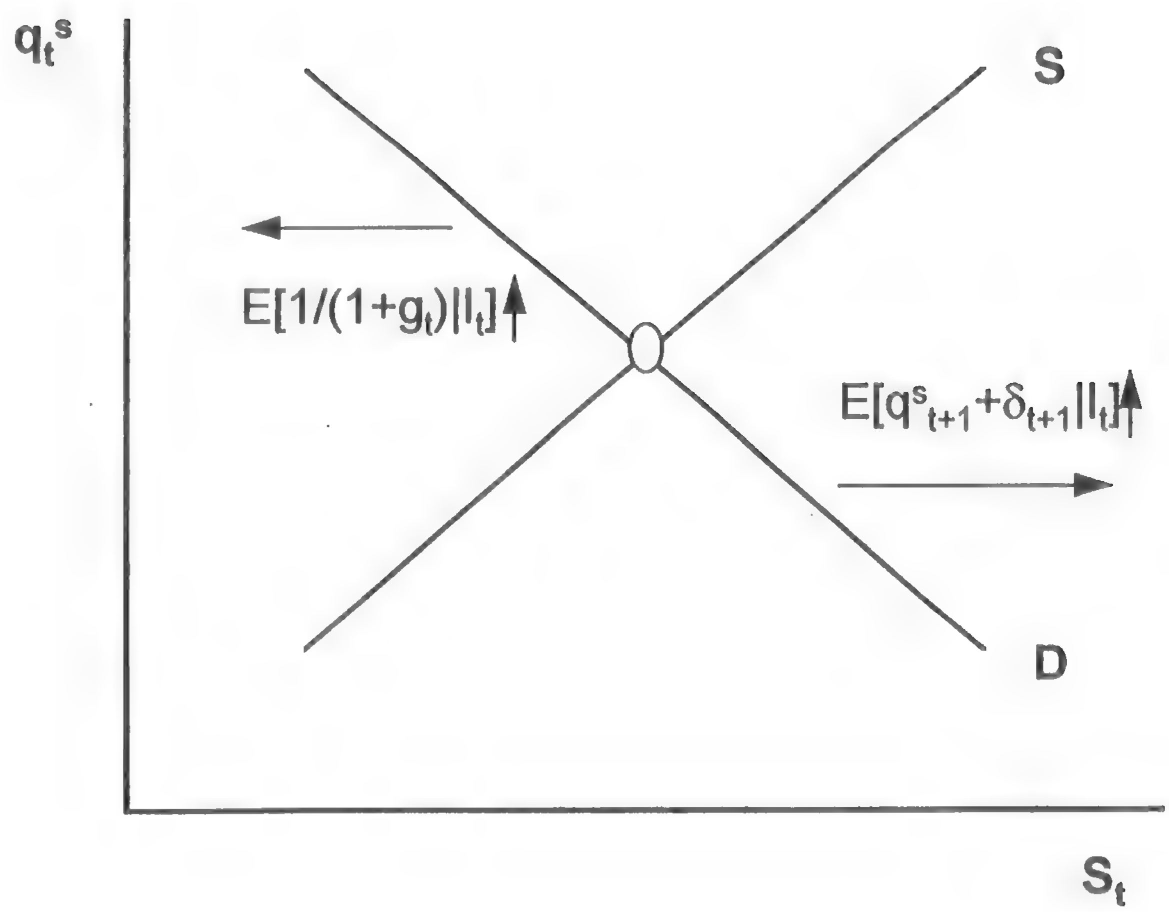


Figure VIII.10 Stock Market

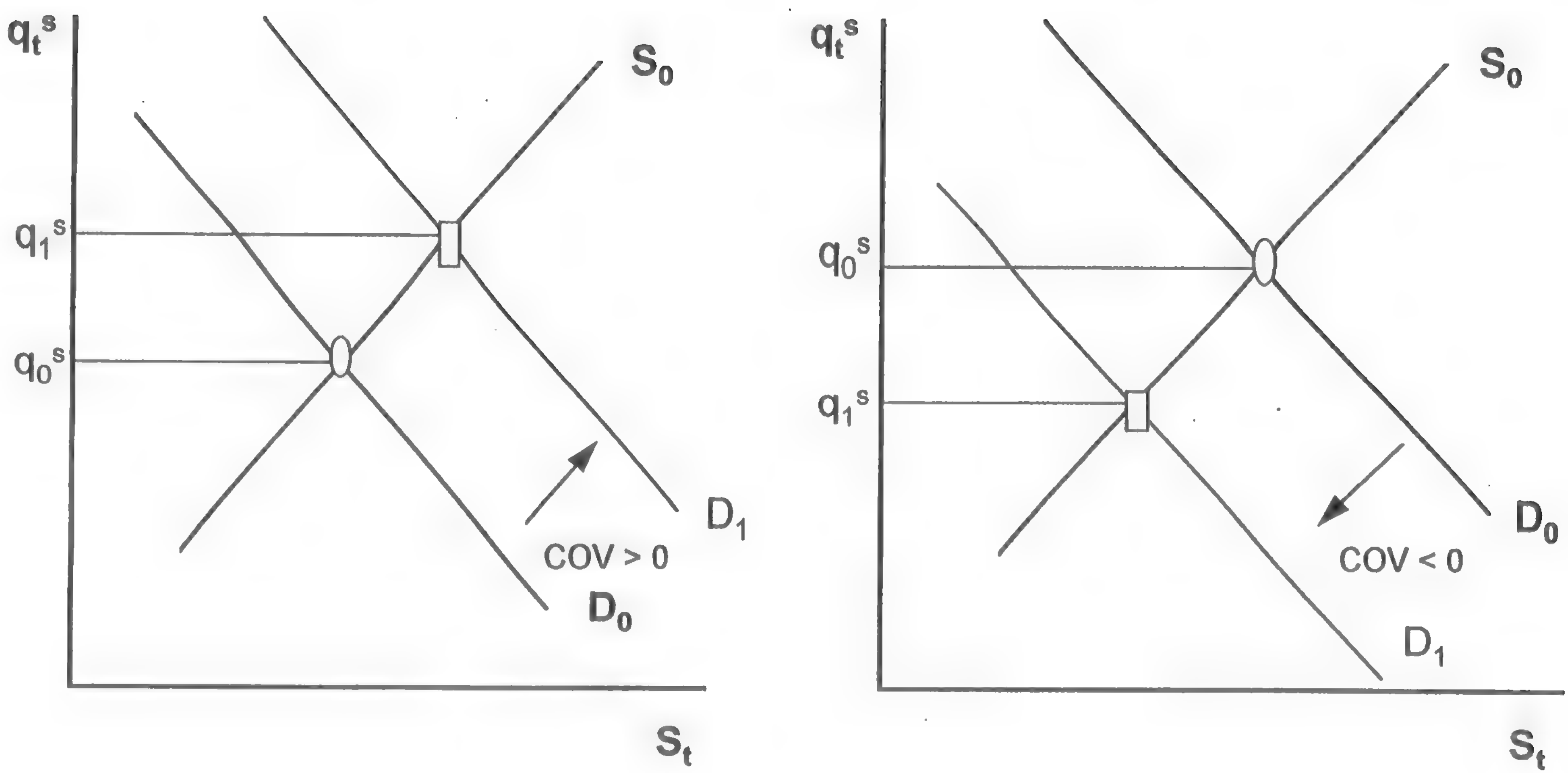


Figure VIII.11 Stock Prices: Effect of Risk

Pricing the Market Portfolio

In our framework, referred to as the CCAPM (consumption capital asset pricing model), the risk is associated with economic factors like inflation and the business cycle (i.e. real GNP growth). These are systematic factors that affect all stocks (i.e. the market). But the same intuition should hold. If the market return is high just when the economy is in a boom, stocks don't provide much hedge against recessions (i.e. the market return will be low in a recession). Then the "market" must be associated with a high return in order to compensate the investor for risk.

The procyclicality of dividends and earning means the equity market must yield a higher return than less risky short term bonds. This higher return or premium on stocks is known as the **equity premium**.

D. ARBITRAGE PRICING THEORY

To be completed.

E. SUMMARY

An important part of the determination of bond prices is the role of expectations. At the time that a decision to purchase a bond is made, the only information available to the saver is the current bond price and the current consumption goods price (CPI). What's relevant, however, is not how many dollars you receive in the future associated with your bond holding, but how many goods you will be able to purchase. To know this, obviously you would have to know the future price of consumption goods. Only God, and maybe Alan Greenspan, knows that. So to decide whether to purchase the bond, a saver must make a forecast of the future price level. Often forecasts are wrong. On average we would expect them to be correct. Furthermore, we would expect forecasters to learn over time from their mistakes. These are two hypotheses that can be tested in the data.

We also studied a general method for pricing assets. We used it to "price" bonds and stocks. Later in the book we will use it to price foreign exchange and forward contracts. In this methodology, you see the role of expectations and risk. In finance classes, the price of *a specific stock* is determined by how it helps to diversify the risk of holding a bundle of stocks. In economics classes, we concentrate on how economic determinants affect the price of *all stocks* or bonds in the market. The pricing method espoused here should illuminate the relation between the economy and systematic (or non-diversifiable or market) risk (the other standard asset pricing relation known as CAPM is concerned with pricing the unsystematic (or diversifiable) risk). The systematic risk is why stocks have a tendency to "move together" and why investors are exposed to "market uncertainties" no matter how many stocks they hold.

To determine the price of a bond or stock - or for that matter any asset - we have to understand the tradeoffs associated with purchasing that asset. In the period in which you purchase the asset (say period t), you give up some consumption which translates into a loss of utility. In the period in which you sell the asset or in which the asset matures (say period $t+1$), you gain some consumption (unknown at the time that you purchase the asset) which translates into an expected future gain in utility. In period t, an agent would purchase assets up to the point where the *present discounted* expected future utility of buying the asset *equals* the current utility loss. This *equality* "prices" the asset.

Suppose the dollar price of the asset is denoted Q_t. To know how much consumption you give up in period t, you have to "deflate" the price (i.e. Q_t/P_t). To know how much consumption you receive in period $t+1$, you have to "deflate" the sales or maturity price (i.e. Q_{t+1}/P_{t+1}) as well as any dividends or coupons that you received (i.e. d_{t+1}/P_{t+1}). In the particular case of a one-period discount bond, the maturity price is 1 and there are no dividends.

If agents are **risk neutral**, then the asset pricing equality simply boils down to our typical breakdown of nominal interest rates into real interest rates (which will simply reflect agents' impatience) and expected inflation in the case of bonds or boils down to the typical relation that the real price of a stock is the present discounted value of expected future real earnings paid out as dividends.

If agents are **risk averse**, another term enters the asset pricing equality reflecting how the asset insures the agent's intertemporal consumption pattern. If the economy is expected to be in a boom (i.e. the growth rate of real GNP is expected to be high) then agents will borrow (issue bonds) or sell stocks. Both actions put downward pressure on prices (for an example, see the 3/30/94 WSJ article on consumer sentiment and bond prices). Furthermore, with risk averse consumers the price of the asset will reflect how the asset's return covaries with the growth rate of real GNP. In the case of a bond, if the inflation rate covaries negatively with the growth of real GNP, then the real payout of the bond is low just when the economy is in a recession. In this case the bond would be a "risky" asset in its role of smoothing agents' consumption and would necessitate a high return to compensate the investor for that risk. In the case of a stock, if future dividends covary positively with real GNP growth, then the stock payout is low just when the economy is in a recession. In this case, the stock would be a "risky" asset in its role of smoothing agents' consumption and would necessitate a high return to compensate the investor for that risk. The pro-cyclicality of real dividends is one reason for the high premium of equity above short term bonds.

Chapter IX

THE LABOR MARKET

Until now we have implicitly assumed everyone is self-employed (e.g. consultants) deciding how many hours to work. In this chapter we will add an explicit labor market where agents sell their labor hours to firms. We will see there was no loss in generality by making the previous assumption.

Why should managers care about the labor market? It is important to understand wage determination, which is a major component of costs in a manager's production decision.

This section will highlight:

a) The role of technology and the demand for labor by firms.

b) The role of preferences and the supply of labor by households.

c) The determination of equilibrium wages and employment.

d) The role of government policies (e.g. the Clinton Health Care Plan) on macroeconomic variables.

A. LABOR DEMAND BY FIRMS

Question: What are firms interested in?
Answer: Maximizing Profits.

$$\text{Profits}_t^j = \text{Revenue}_t^j - \text{Cost}_t^j = P_t \bullet y_t^j - W_t \bullet n_t^{dj}$$

where P_t $\equiv$ price level
y_t^j $\equiv$ output of firm j
W_t $\equiv$ nominal wage
n_t^{dj} $\equiv$ labor hours demanded by firm j

Now we will assume that the firm is the owner of the technology:

$$y_t^j = \theta_t f(n_t^{dj}; k_{t-1}^j)$$

where we will now assume that the firm has some existing capital k_{t-1}^j (e.g. buildings or equipment).

What are the assumptions we make about the technology that relates labor input to goods output?

Assumption 1: Law of Diminishing Returns

Eventually workers get in each other's way. See Figure IX.1.

Assumption 2: Labor Augmenting Capital or Technological Change.

As capital or technology rise, workers become more productive. See Figure IX.2.

These assumptions on technology form the basis for the labor demand curve.

Profit maximizing Choice of Labor

As can be seen in Figure IX.3, the maximum occurs where:

marginal revenue product of labor (p•mpn) = marginal cost of labor (W) in nominal terms

or $$\text{mpn} = W/P \equiv w \text{ (in real terms)}$$

This says that the firm will hire laborers to the point where their additional output just compensates their additional real cost.

This relationship defines a labor demand curve under competitive conditions (i.e. firms take W and P as given). The labor demand curve is simply the marginal product of labor curve. See Figure IX.4.

Ques: What shifts Labor Demand Curve?

Ans: Increases in capital or technological change (i.e. the same things that shifted mpn).

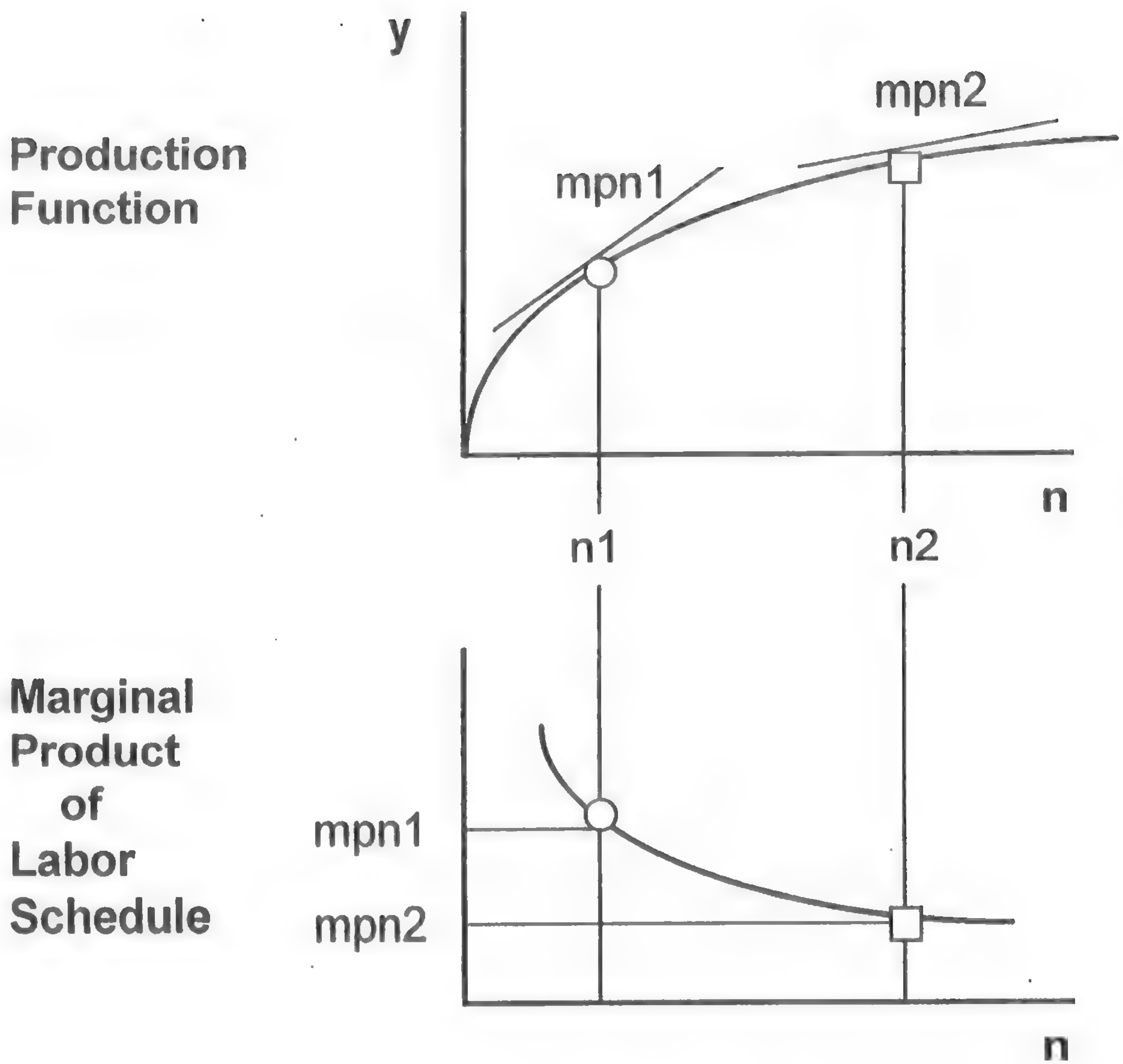


Figure IX.1 Law of Diminishing Returns

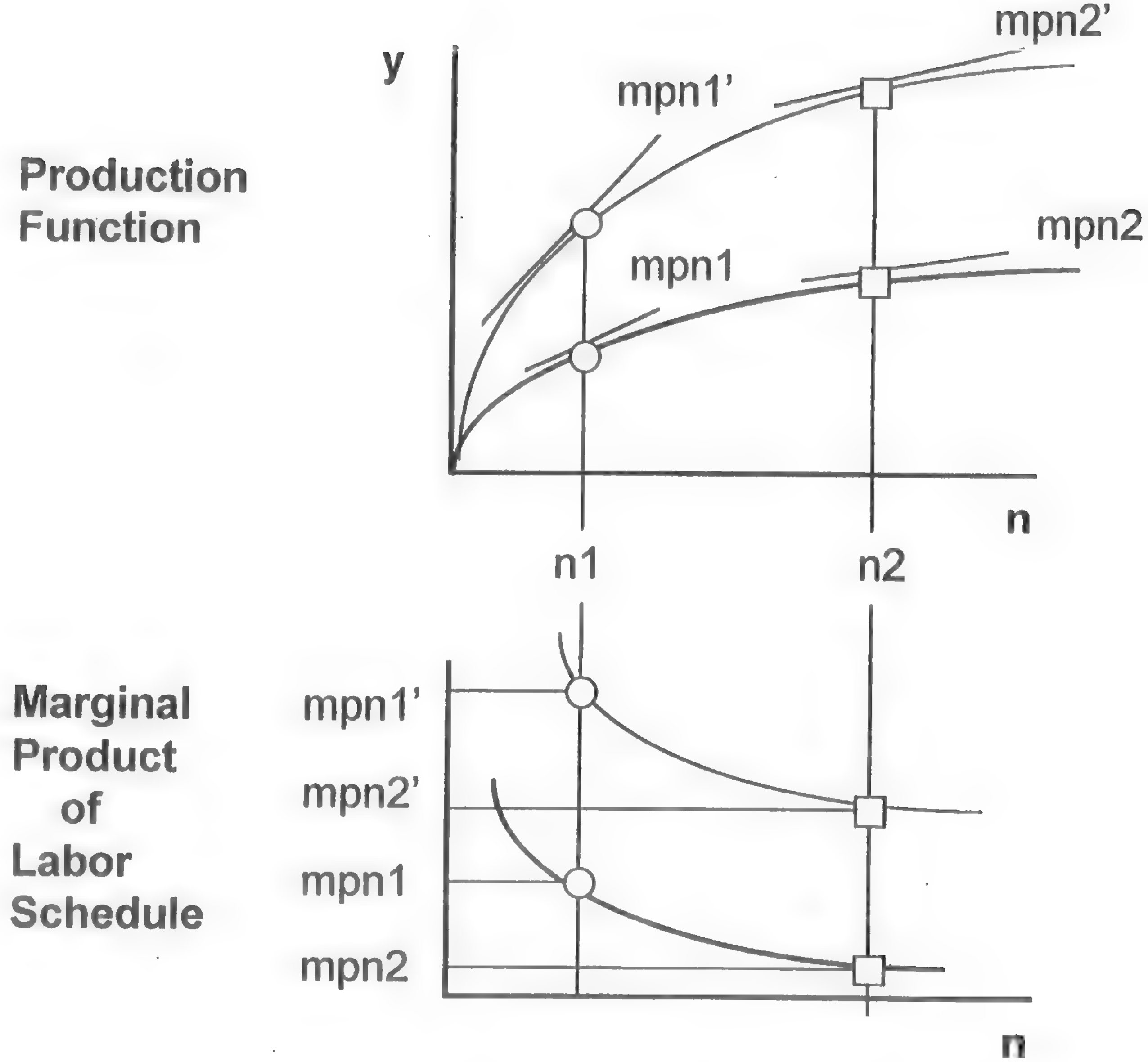


Figure IX.2 Technology Change

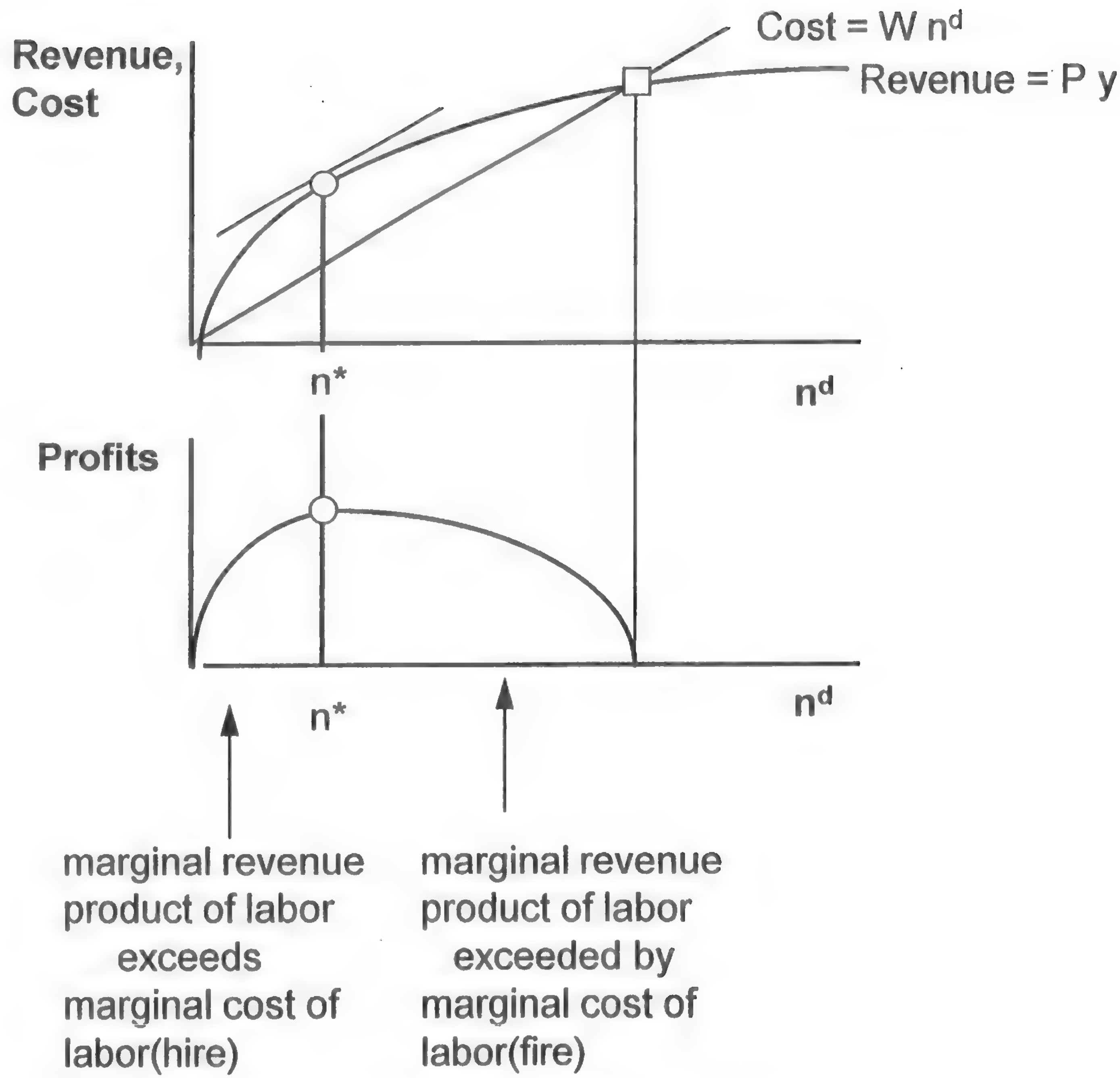


Figure IX.3 Choice of Labor

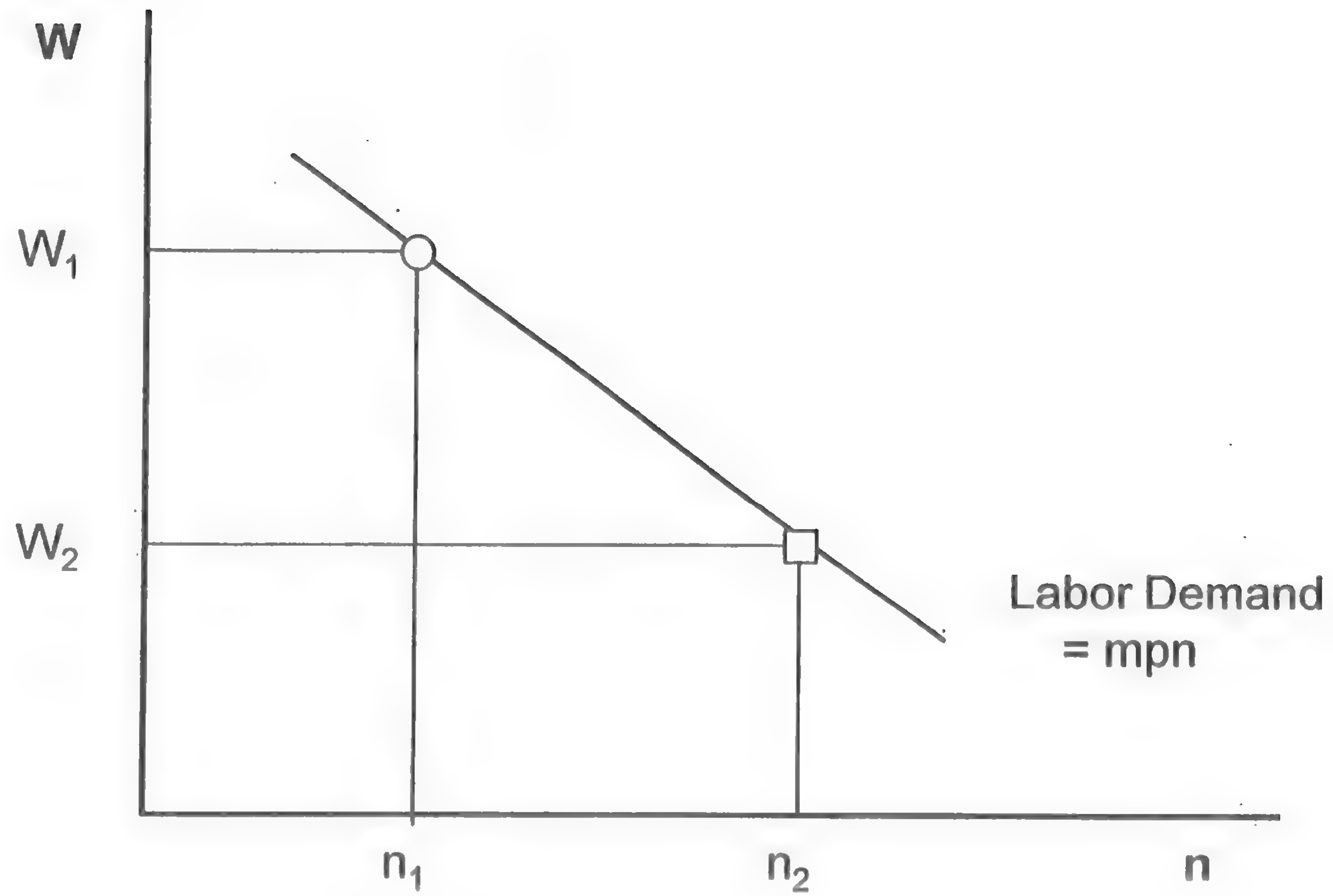


Figure IX.4 Labor Demand Curve

B. LABOR SUPPLY BY HOUSEHOLDS

What are households interested in?

Maximize Utility

subject to their budget constraint

Let's reconsider the intra temporal labor/leisure choice problem. The household's intratemporal budget constraint is given by:

expenditure	=	receipts
$P_t c_t^j$	=	$W_t\,(1-\tau_t)n_t^{sj}$

where W_t ≡ nominal wage
τ_t ≡ marginal income tax rate
n_t^{sj} ≡ labor hours supplied by household j

So the household chooses consumption and leisure (or, alternatively labor supply) in order to:

$$\text{Max } U(\overset{+}{c}{}_t^j, \overset{-}{n}{}_t^{sj})$$

$$\text{s.t.} \quad c_t^j = w_t(1-\tau_t)n_t^{sj}$$

We assume that preferences are as before (the same as Robinson Crusoe's). The budget constraint now reflects the fact that the firm is the owner of the technology and the worker gets paid a market determined real wage (w_t).

We can picture the household's problem as in Figure IX.5.

How do we derive the labor supply curve (i.e. the amount of labor that a household will supply for a given real wage rate)? Consider two different real wage rates $w_0 < w_1$ at time t. See Figure IX.6.

Illustrating Income and Substitution effects

A standard upward sloping labor supply curve is illustrated in Figure IX.7 where substitution effects outweigh income effects. If income effects outweigh substitution effects we could get a downward sloping curve as in Figure IX.8.

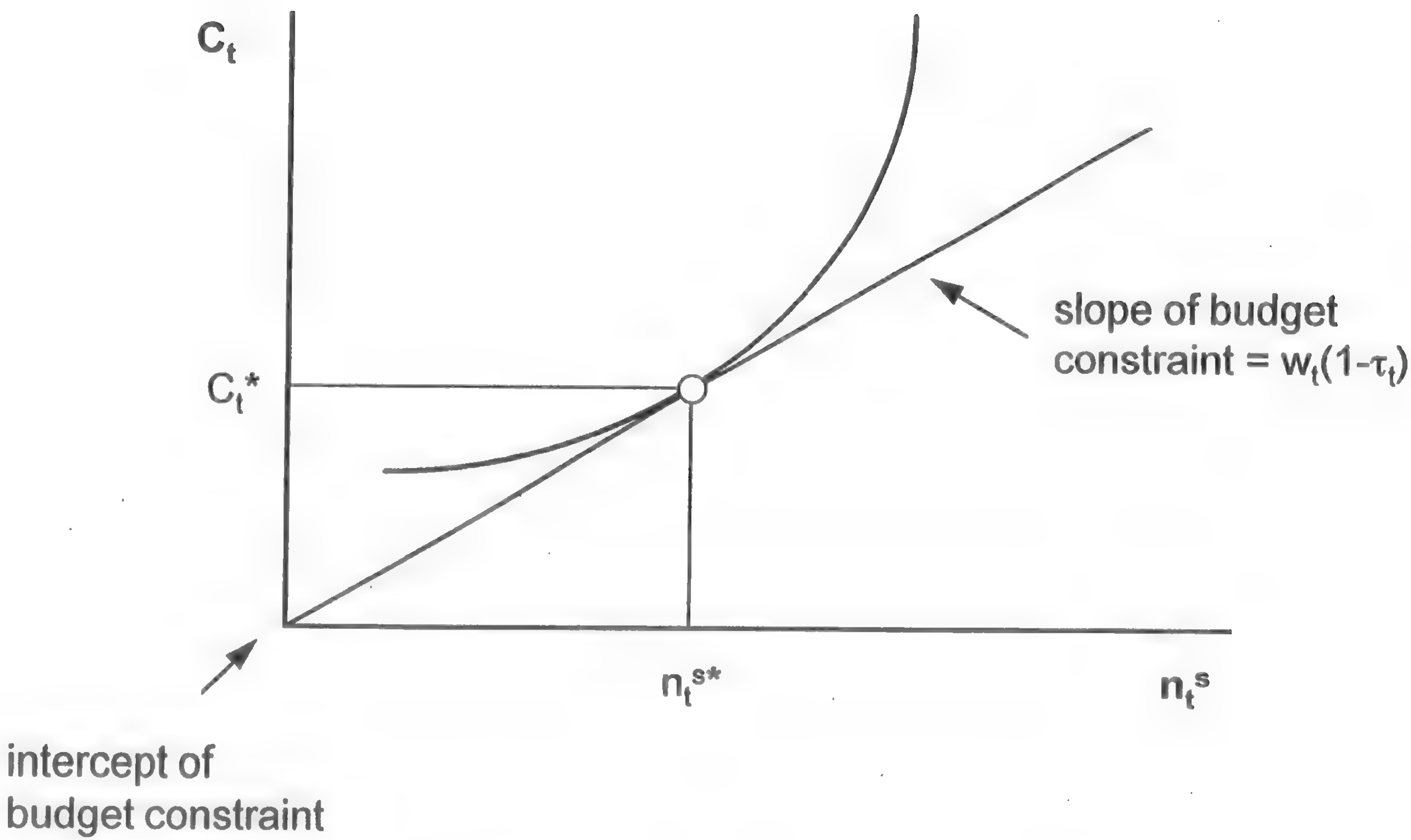


Figure IX.5 Household's Problem

These preferences exhibit greater substitution effects than income effects.

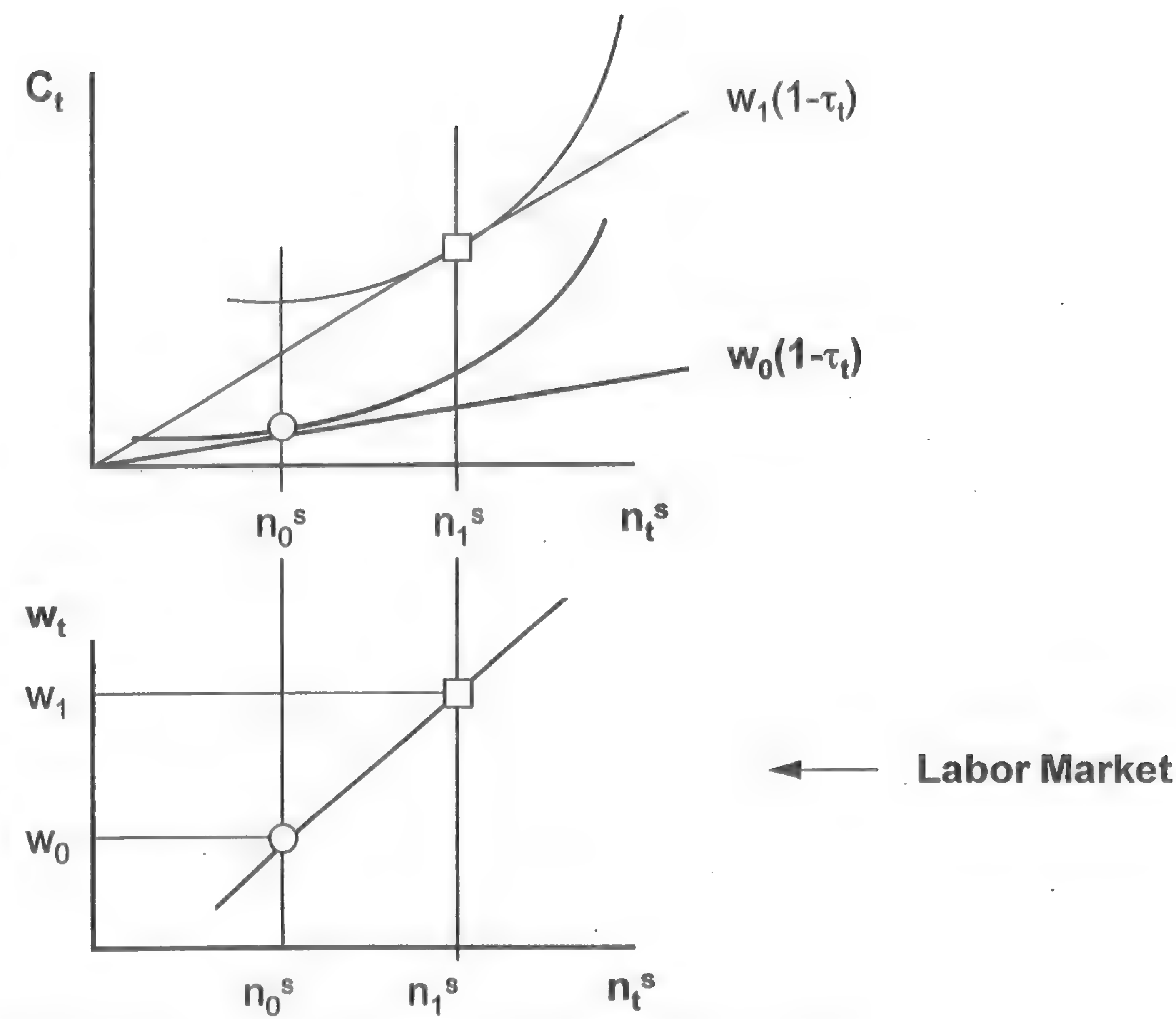


Figure IX.6 Derivation of Labor Supply Curve

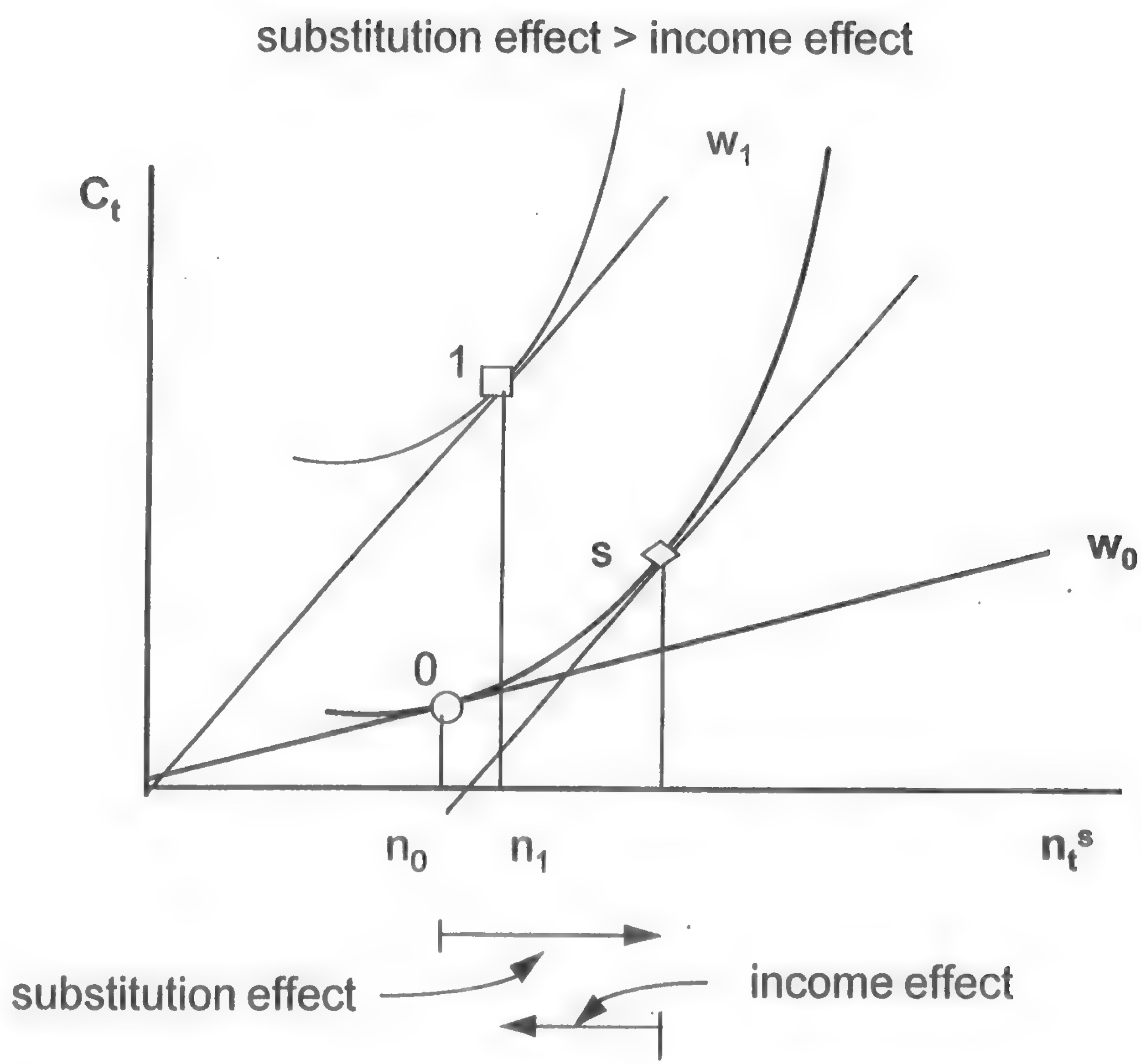


Figure IX.7 Upward Sloping Labor Supply Curve

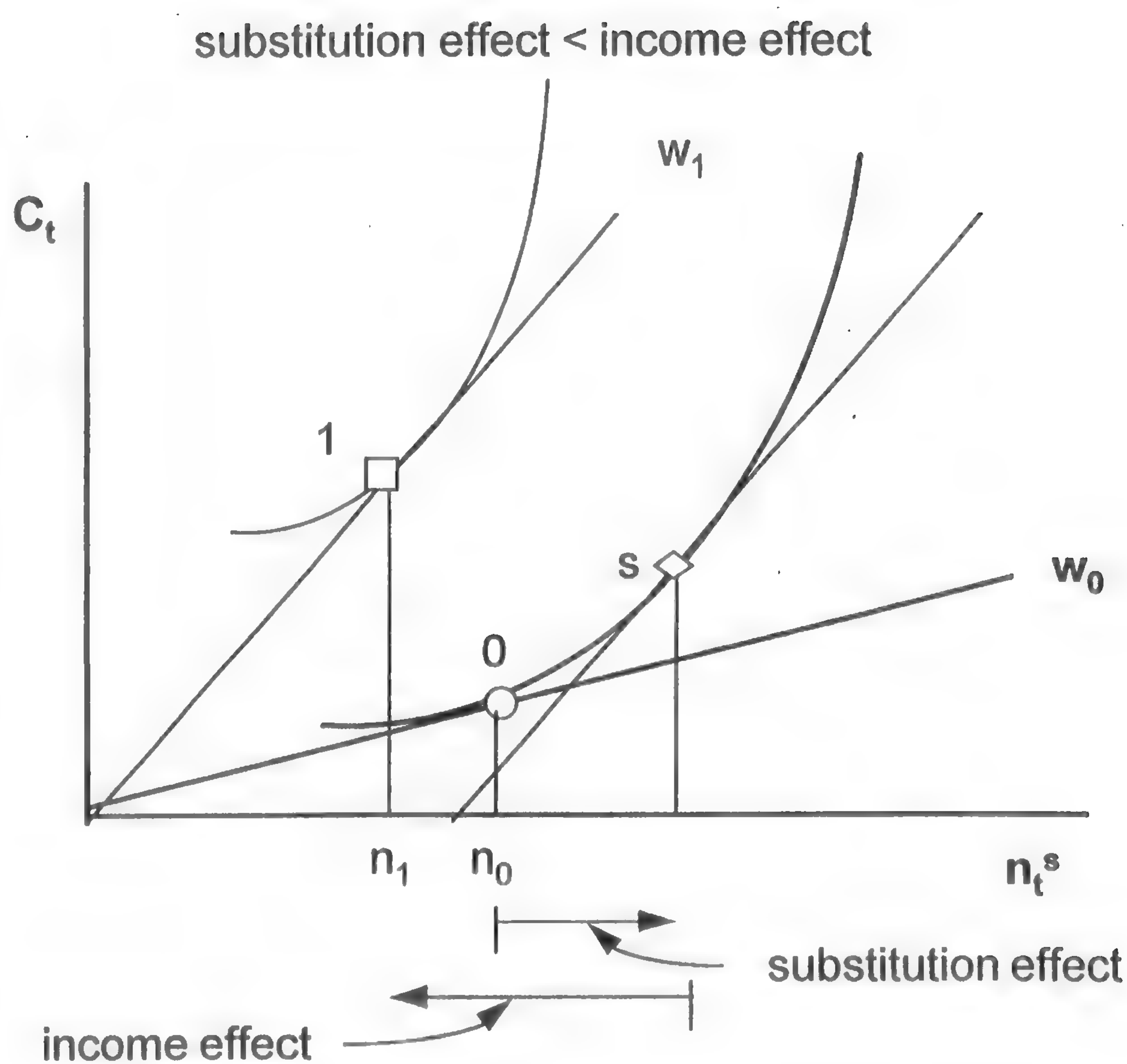


Figure IX.8 Downward Sloping Labor Supply Curve

Factors that shift the Labor Supply Curve (See Figure IX.9)

a) Consider a decrease in marginal tax rates from τ_0 to τ_1 (in period t) while the real wage remains at w_0. This amounts to a rise in the after-tax real wage rate, which from the previous page leads to a rise in labor supply (a rightward shift of the labor supply curve).

b) Let's reintroduce intertemporal effects. The agent's intertemporal budget constraint is:

$$c_t^j + \frac{c_{t+1}^j}{1+r_t} = w_t(1-\tau_t)n_t^{sj} + \frac{w_{t+1}(1-\tau_{t+1})}{1+r_t} n_{t+1}^{sj}$$

Now an increase in r_t raises the cost of consuming leisure today relative to the future. An agent would substitute into future leisure, working more today (in order to save for the future). Another way to say this is that an increase in r_t lowers the future return to work $\frac{w_{t+1}(1-\tau_{t+1})}{1+r_t}$, so people work more now (i.e. the labor supply curve shifts rightward).

c) Consider a rise in future tax rates (τ_{t+1}). Once again, this lowers the future return to work. People work more now (a rightward shift of the labor supply curve).

C. LABOR MARKET EQUILIBRIUM

Just put the two graphs together as in Figure IX.10.

What are the determinants of nominal wages (W)?

a) Prices (P): a higher price level means a lower real wage since $w=W/P$. If substitution effects outweigh income effects, agents will substitute into leisure (or lower labor supply). The resulting excess demand for labor puts upward pressure on nominal wages to restore the original real wage.

b) Technology (θ, f, k): higher productivity raises the demand for labor and raises the real wage.

c) Preferences (U): individuals' attitudes towards work determines how much labor they will supply.

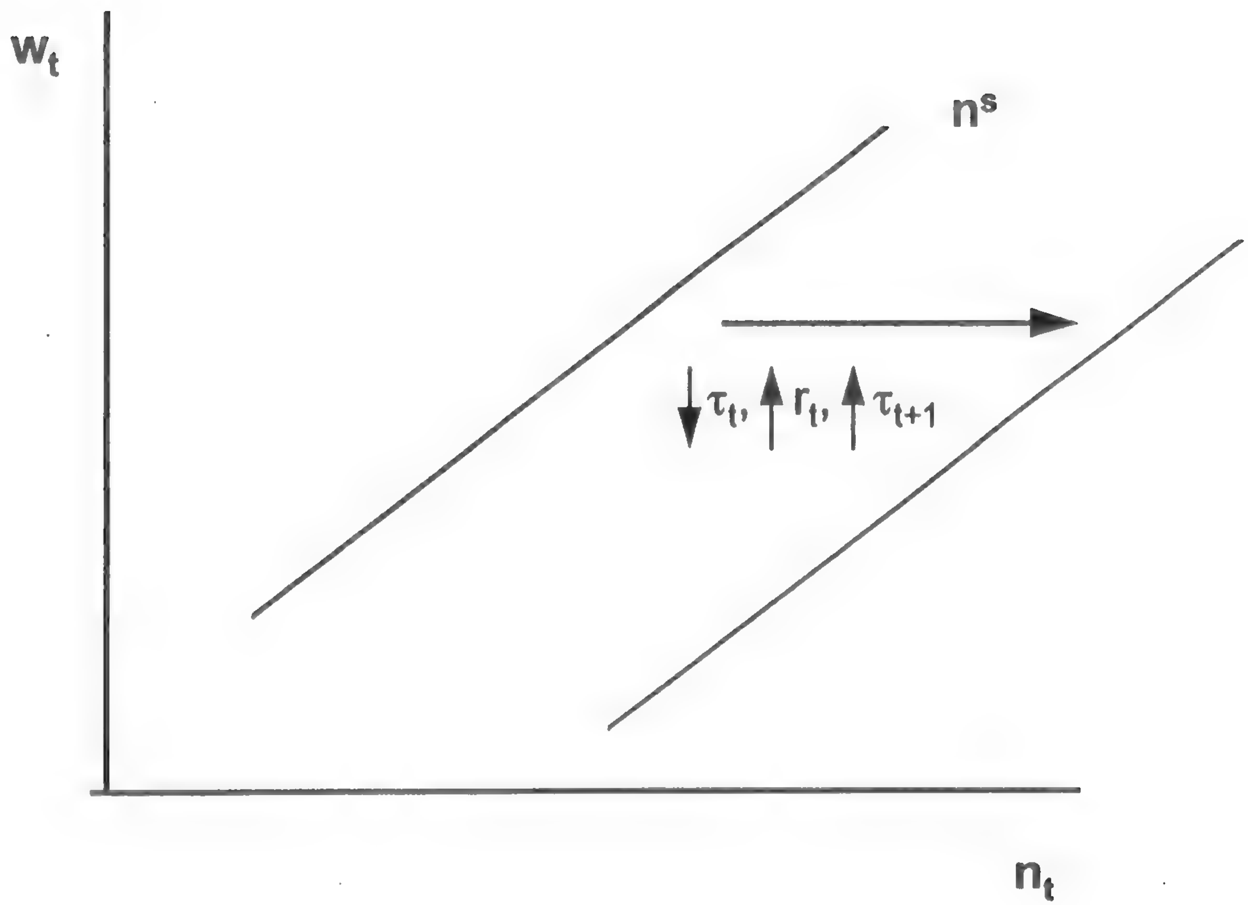


Figure IX.9 Factors Shifting the Labor Supply Curve

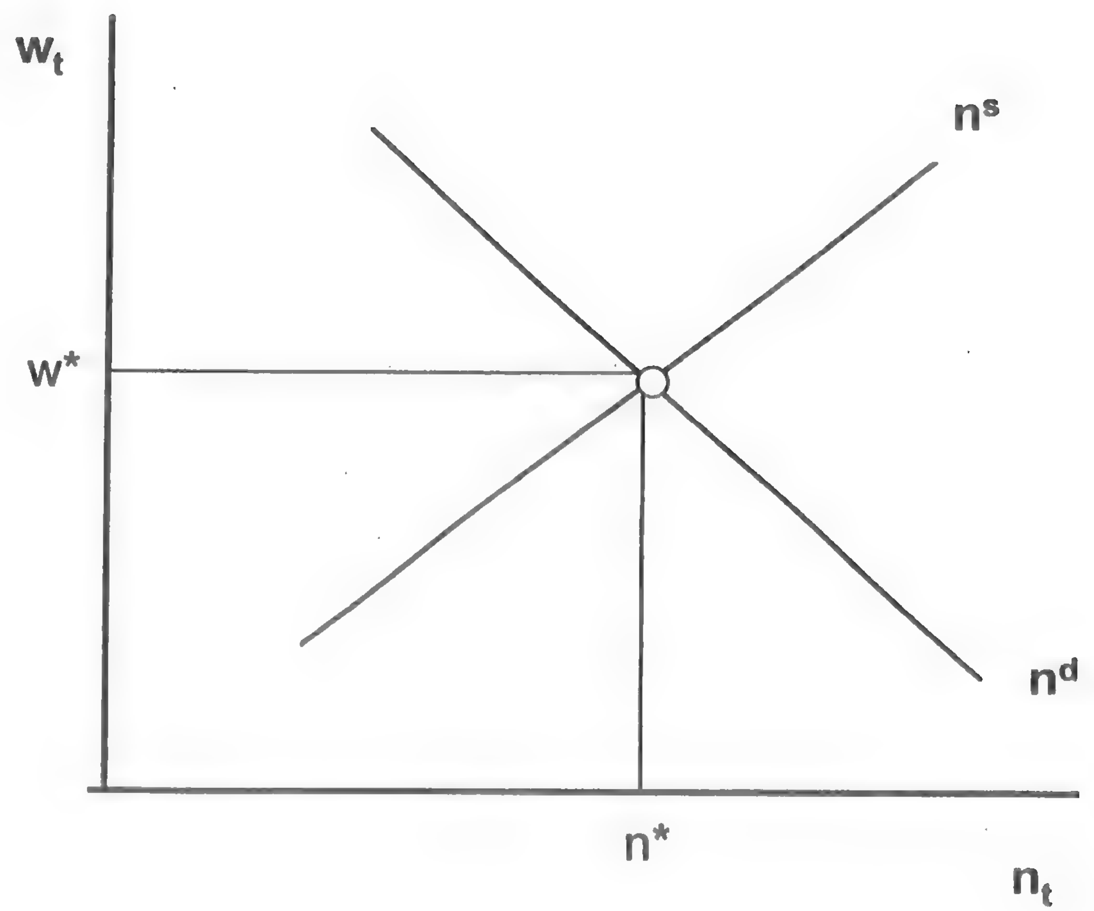


Figure IX.10 Labor Market Equilibrium

d) Government policy (e.g. τ): an increase in personal tax rates, by lowering agents' after-tax real wages, leads to a lower supply of labor (if substitution effects > income effects).

e) Interest Rates (r): an increase in real interest rates makes current leisure more expensive. Agents will work more today and take their leisure in the future.

A change in any variable (b)-(e) implies a shift in the labor demand or supply curves (recall, variables (b)-(e) do not appear on any axis of the labor market diagram). A change in real wages (i.e. W or P) is seen as a movement along the curve.

Now we can use the labor market diagram to analyze the effects of the oil price shocks in '73-'74 and '79-'80 on real wages and employment. See Figure IX.11. The goods, bond, and money market predictions are as before: $\downarrow Y_t$, $\uparrow r_t$, $\uparrow P_t$. But now the labor market prediction is: $\downarrow w_t$, $\downarrow n_t$. That is, employment and real wages fall. Nominal wages (W) rise, but not enough to offset the rise in prices (P).

A Policy Experiment

What will the requirement that firms pay, in part, employees' health care benefits do to the economy?

This amounts to a tax paid by employers to the "health care officials".

$$\text{Real profits}_t = \theta_t f(n_t, k_{t-1}) - w_t n_t - \tau_t^{HC} n_t$$

where $\tau_t^{HC} \equiv$ real health care benefits.

Now the profit maximizing choice of labor must satisfy:

$$mpn = w + \tau^{HC}$$

Since the real marginal cost of hiring workers has risen, firms hire less workers. See Figure IX.12.

At the existing real wage, the effect of the tax is to lower labor demand (n^d). This amounts to a shift of the labor demand curve. See Figure IX.13. The general effects are to lower real output and raise real interest rates and prices. This was a worst case scenario. Now that employment yields higher benefits, people outside of the labor force or even those employed might work more.

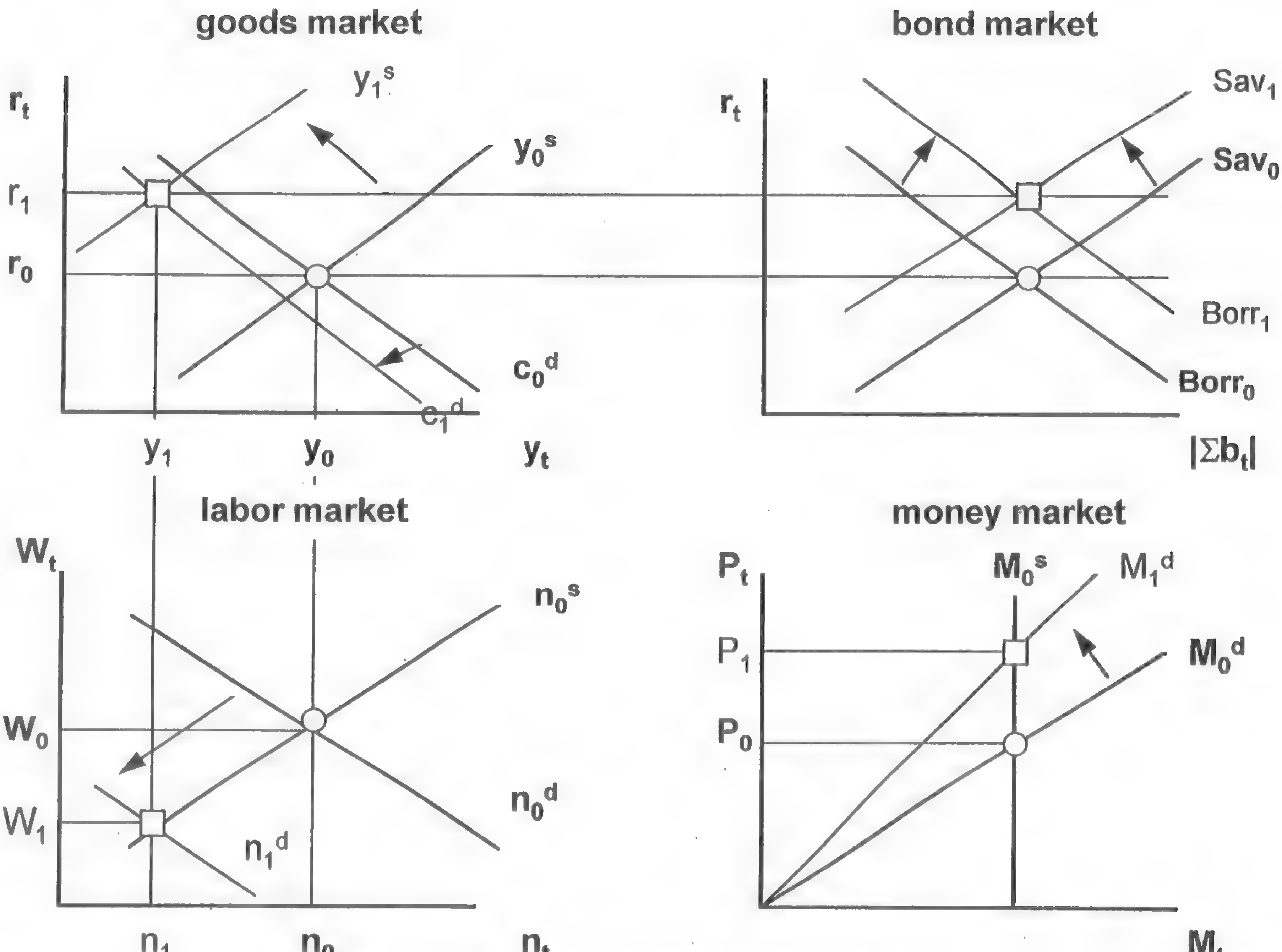


Figure IX.11 Effects of the Oil Price Shock

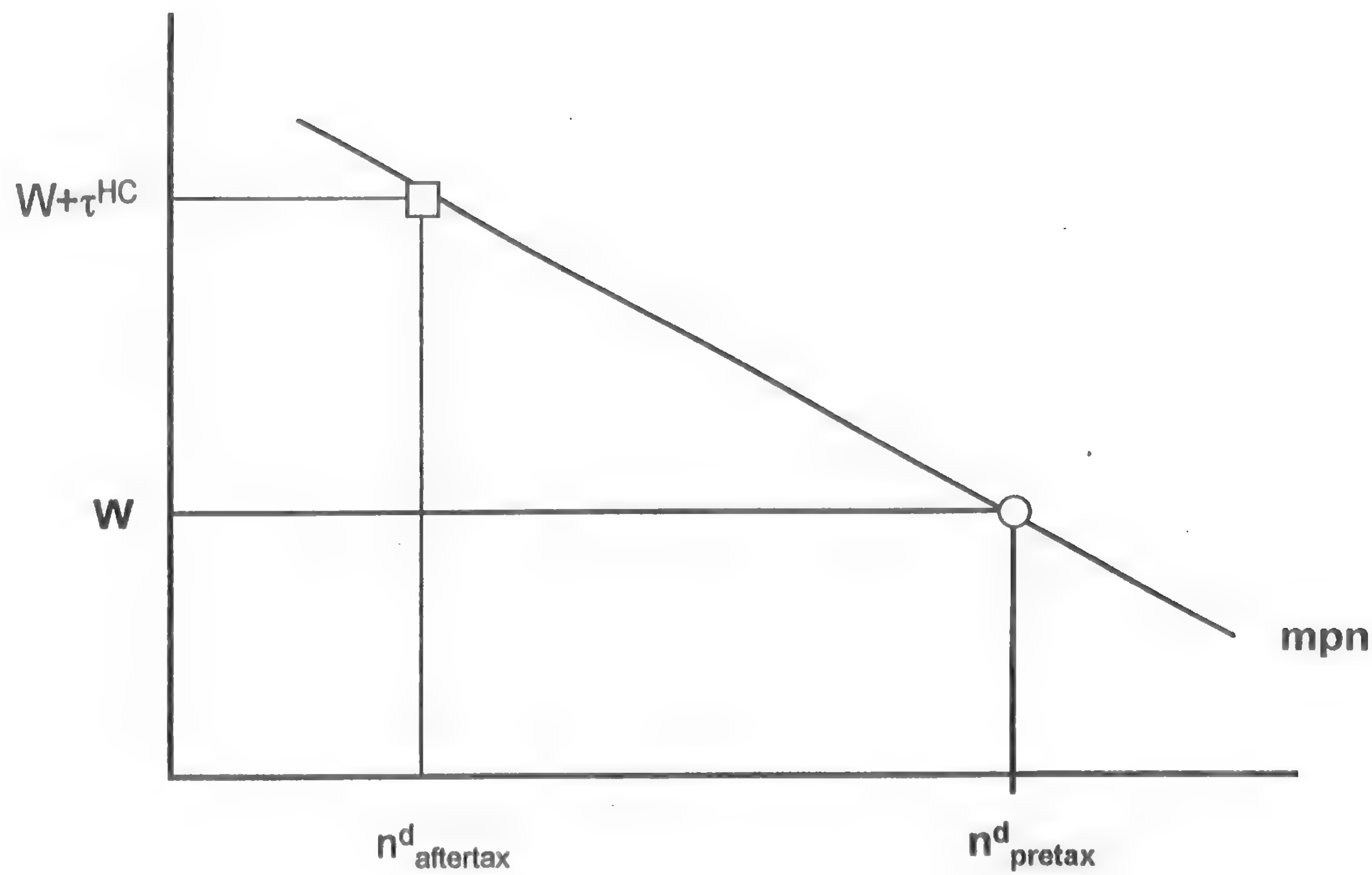


Figure IX.12 Health Care Benefits

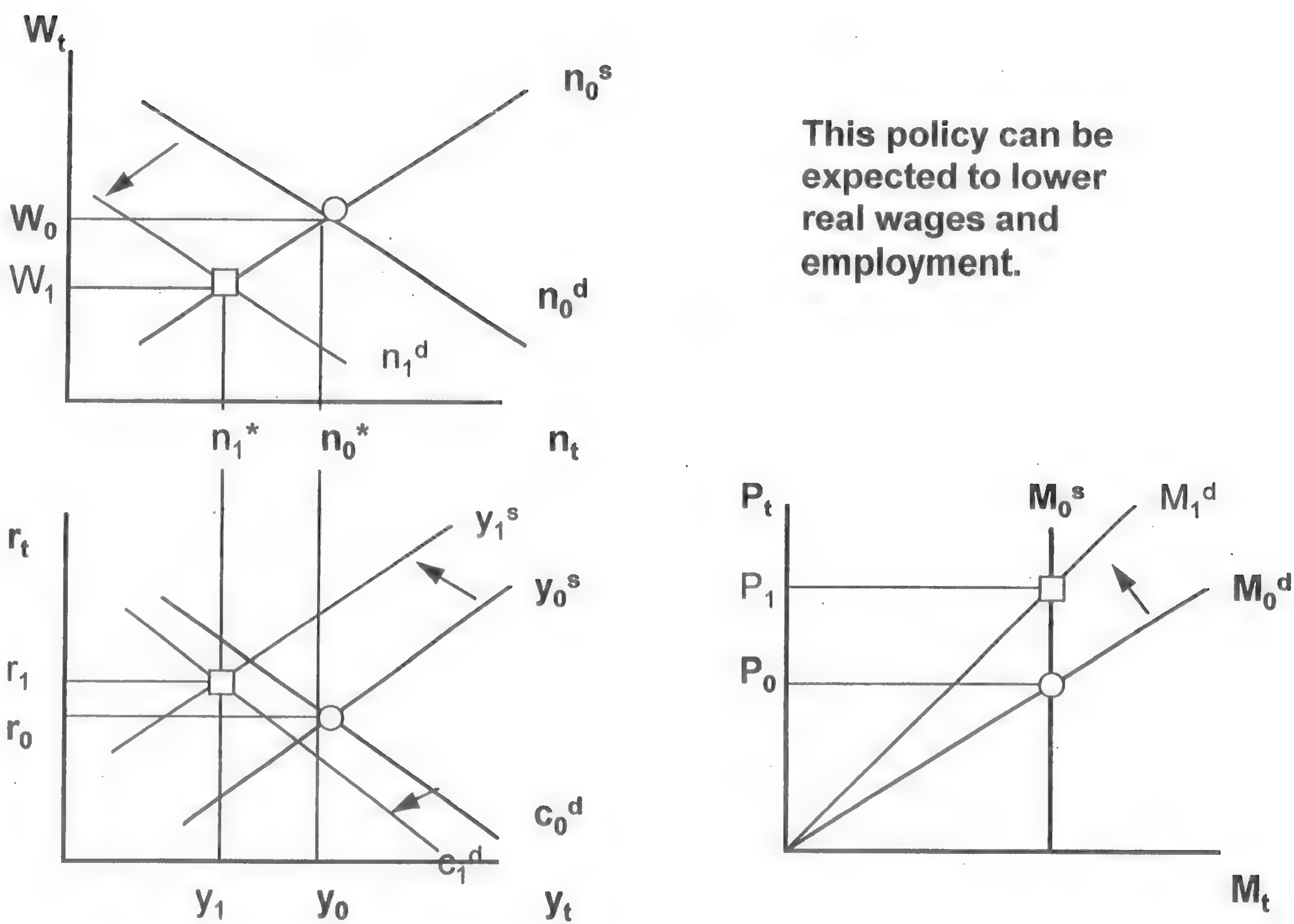


Figure IX.13 Effects of the Health Care Tax

D. SUMMARY

In this chapter we studied the labor market in order to understand the determinants of wages and labor hours (or employment). Knowledge of wage determination is relevant for managers since approximately 65% of the costs of running a firm are related to compensation of employees (this figure comes from the National Income and Product Accounts). Like any market, the labor market has two sides: demand for labor by firms and supply of labor by households.

In competitive labor markets, firms take wages as given. Firms demand labor to the point where the additional revenue of a worker hour just equals the additional cost. In real terms, this translates to the point where the marginal product of a worker's labor equals her real wage. So if the real wage was to rise, the firm must choose a number of worker hours such that the marginal product also rises. Given that we have assumed that there are diminishing returns to labor, the number of worker hours would have to be small. This implies the labor demand curve is downward sloping. What shifts the demand for labor? Anything that changes the marginal product of labor (e.g. technology shocks).

Households supply labor to the point where the benefit of working an additional hour equals the additional cost. In other words, where the after-tax real wage earned just compensates the worker for the lost utility associated with less leisure. So if the real wage was to rise, and substitution effects outweigh income effects, the marginal benefit exceeds the cost and the worker would raise her supply of labor. This implies the labor supply curve is upward sloping. What shifts the supply of labor? Anything that changes costs (e.g. shocks to preferences) or benefits (e.g. taxes or real interest rates).

Once we have the two sides of the labor market, we can predict what happens to real wages and hours when one of the "shift" variables changes. We can also integrate the labor market with the goods, bond, and money markets to understand the aggregate consequences (note that Walras' Law still holds - now we need to clear 3 of the 4 markets). For instance, we can go back to the technology shocks associated with the oil crises of '73-'74 and '79-'80. The oil price rise altered the efficient use of labor; if workers are less productive at the margin, firms will employ less labor hours. The excess supply of labor put downward pressure on real wages. The lower number of labor hours employed, along with the lower marginal product, led to a decrease in the aggregate real supply of goods, which is what we saw in earlier chapters.

Chapter X

THE CAPITAL GOODS MARKET

Until now we've been studying the production and consumption of *non-durable goods and services* (by definition a service is not long lasting). Many goods last many years. Plant and equipment used by producers, as well as houses and consumer *durables* like autos, have long lifetimes. All of these goods fall into the category of investment (broadly defined).

If we look at the cyclical properties of non-durable goods and services consumption versus the cyclical properties of broadly defined investment we see a stark difference. While both are procyclical, nondurable consumption is relatively smooth across the cycle. On the other hand, investment is extremely volatile (for a comparison of nondurables versus investment volatility, see Figures X.1 and X.2).

Before studying the determinants of investment we need some definitions.

Definition The *private fixed capital stock* is composed of business's durable equipment and structures plus residential structures. We denote firm j's holdings of capital at the end of period t as k_t^j.

Definition *Consumer durables* are composed of household goods that last a long time (e.g. autos, refrigerators, etc.)

Definition *Investment* is the *change* in the capital stock. If we denote the aggregate capital stock as $K_t \left[= \sum_j k_t^j \right]$ then *gross investment* is defined by

$$I_t = K_t - K_{t-1} + \delta K_{t-1}$$

where *net investment* is K_t-K_{t-1} and δK_{t-1} is investment to replace worn (depreciated) equipment (δ is the depreciation rate).

A. INVESTMENT DEMAND BY FIRMS

We now consider a firm's decision to invest or add to its capital stock. As in the decision of how much labor to demand, the firm will weigh the marginal cost of another unit of capital against the marginal benefit.

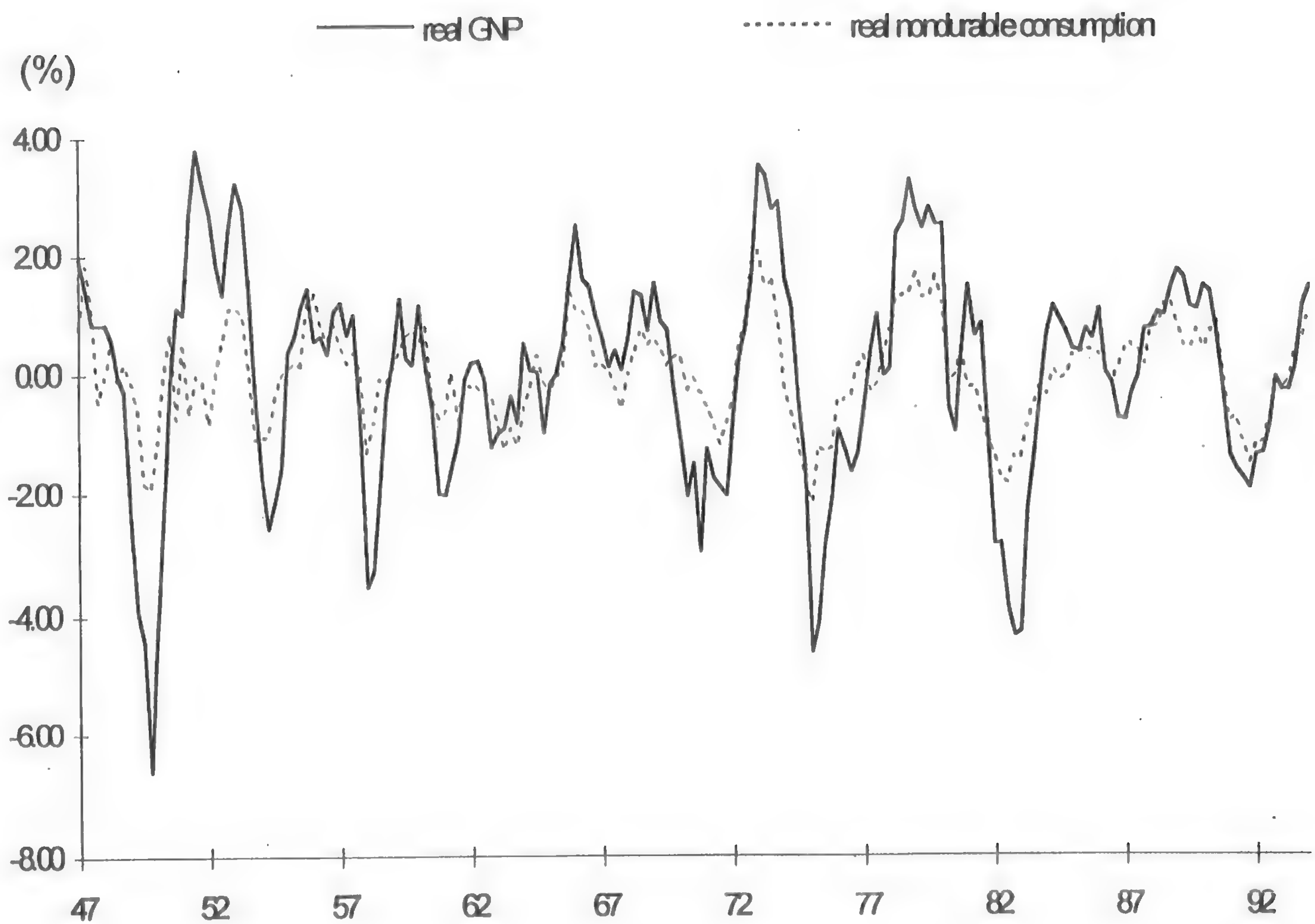


Figure X.1 Deviations from Trend: real GNP and real consumption

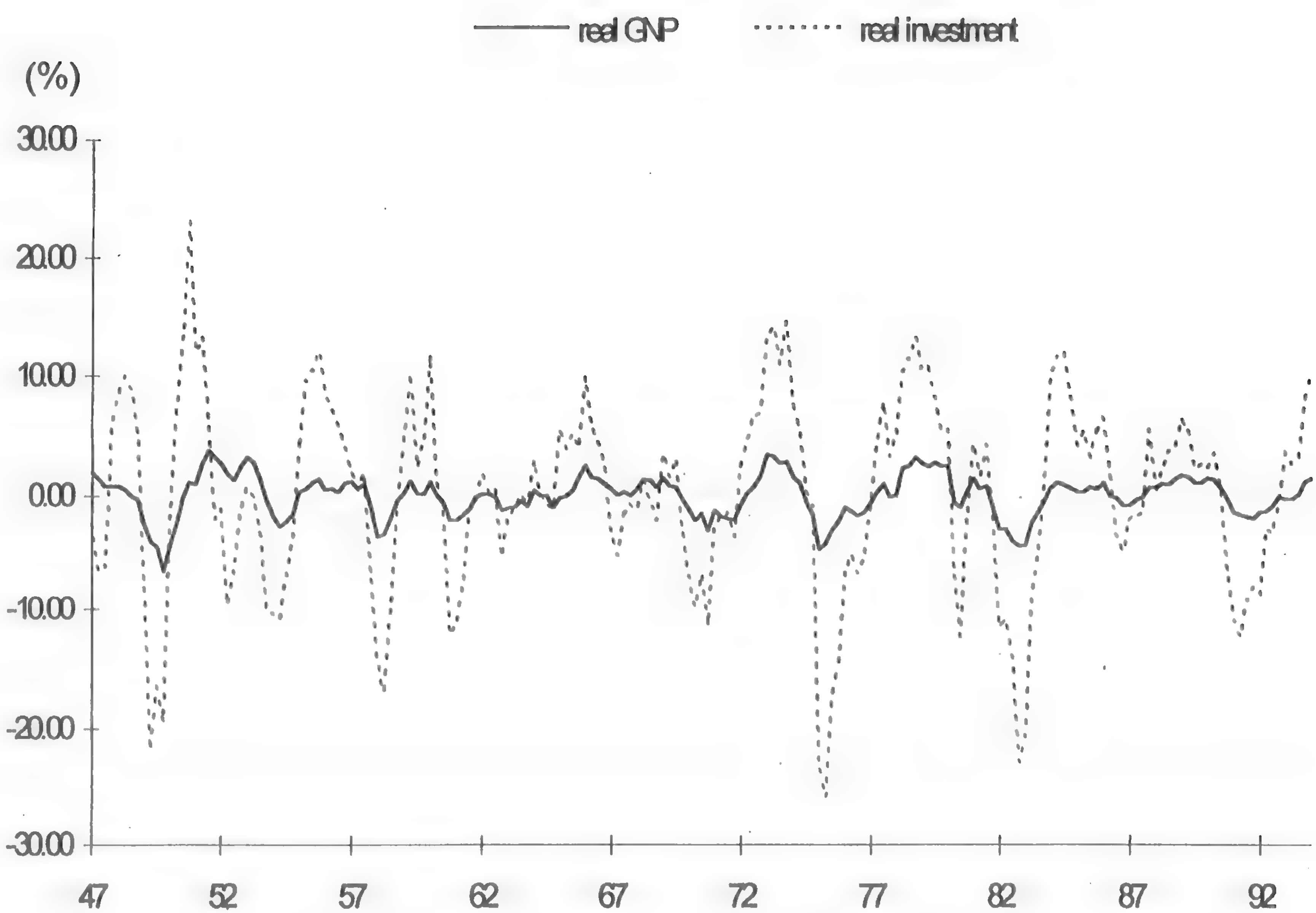


Figure X.2 Deviations from Trend: real GNP and real investment

What is the cost of an additional unit of capital? It is just the price of the new unit of capital. Denote its nominal price P^K_t.

What is the benefit of an additional unit of capital? First, we must recall that capital is an important input into the production of the firm's goods. That is, the firm's production function is given by:

$$y^j_t = \theta_t f(n^j_t, k^j_{t-1})$$

where lagged capital enters because it takes time to build or set up new capital.

What are the properties of the production function with respect to additions to the capital stock? They are similar to what we assumed for the labor input. That is, more capital generates more output but at a decreasing rate due to the law of diminishing returns. See Figure X.3.

Now, an addition to capital at t generates additional output to the firm in subsequent periods (t+1, t+2,...). For simplicity let's just consider the next period (t+1). In t+1, it generates marginal revenue product:

$$P_{t+1}\ mpk_t$$

where mpk_t denotes the addition to output at t+1 from increasing capital at time t (i.e.

$$mpk_t = \theta_{t+1}\frac{\Delta f(n_{t+1}, k_t)}{\Delta k_t}$$

where Δ denotes change.

Second, suppose the firm resold its *remaining* capital on the secondary market at t+1. I say remaining because δ percent of the capital depreciates. Thus, the remaining amount of the one unit addition of capital is (1-δ) which sells at price P^K_{t+1}. This action by the firm generates capital gain:

$$P^K_{t+1}\ (1-\delta)$$

Then the expected discounted benefit of an additional unit of capital at t is:

$$\frac{1}{1+R_t}\, E\left[P_{t+1}\ mpk_t + P^K_{t+1}\ (1-\delta) \mid \Im_t\right]$$

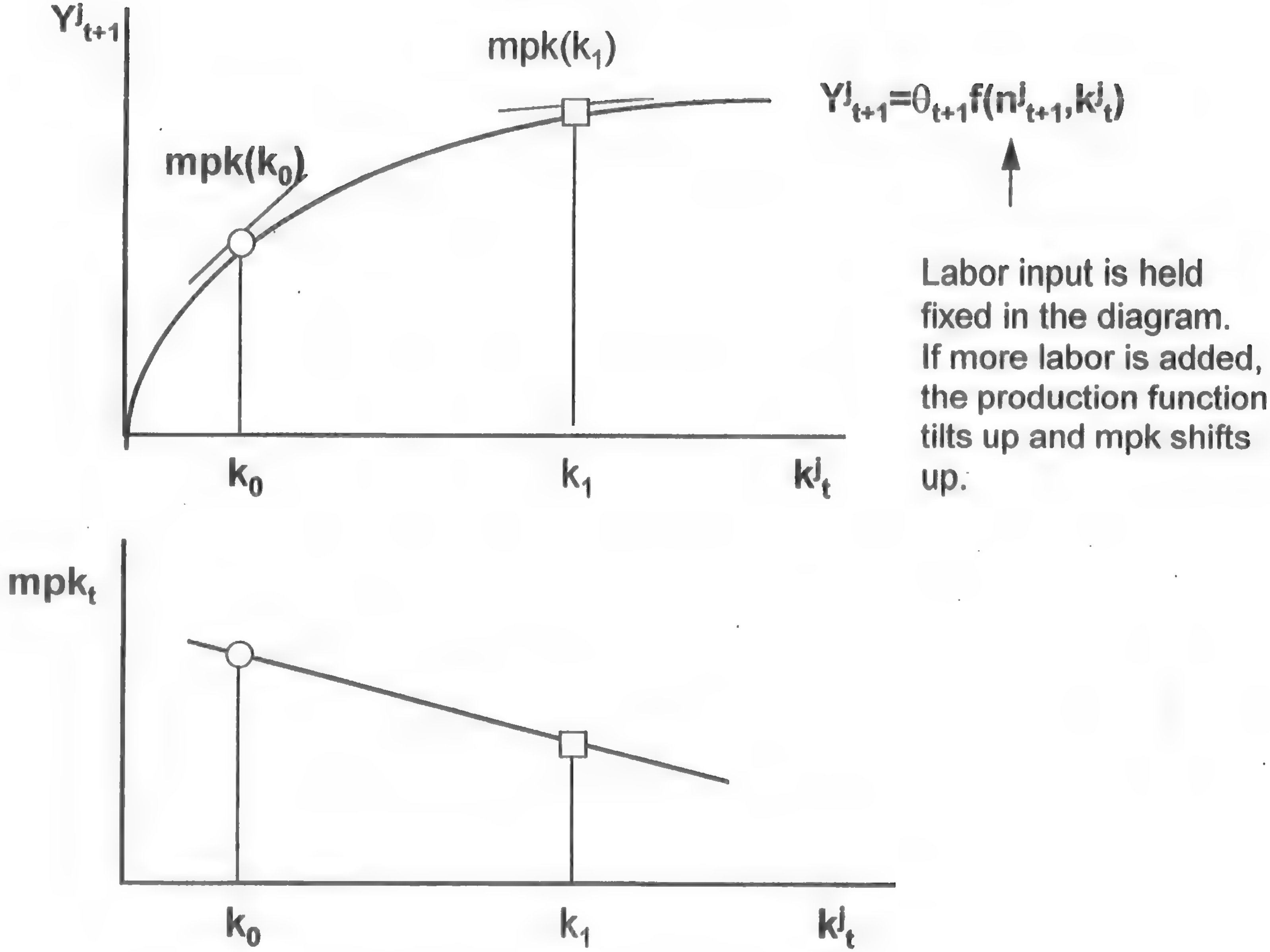


Figure X.3 Law of Diminishing Returns

As in all of our existing decisions, we set marginal cost = marginal benefit. In this case, the firm chooses capital to the point where:

$$P_t^K = \frac{1}{1+R_t} E\left[P_{t+1} mpk_t + P_{t+1}^K (1-\delta) \mid \Im_t\right]$$

Suppose that nondurable consumption goods and services sell at a fraction α of the price of capital goods (i.e. $P_t = \alpha P_t^K$). Then we can simply cross multiply and re-write the equality as:

$$1 + R_t = (1+\pi_t^e) \{mpk_t^e/\alpha + (1-\delta)\}$$

where we have assumed there is no covariance between P_{t+1} and mpk_t for simplicity. With a little more algebra, we can re-write the equation as

$$MPK_t^e - \delta = r_t^e$$

This says the firm will choose capital to the point where its expected additional real revenue net of depreciation equals its expected real financing cost. See Figure X.4.

The properties of the demand for capital are quite simple and can be determined by Figure X.4. The higher are expected real financing costs (r_t^e), the less capital a firm will buy. The higher is depreciation (δ), the less capital a firm will buy. An expected future favorable technology shock (θ_{t+1}) will raise capital demand today (to take advantage of future productivity). These results are summarized in

$$k_t^j(\overset{-}{r_t^e}, \overset{-}{\delta}, \overset{+}{\theta}_{t+1}, \ldots)$$

What do the results on capital demand imply about the properties of investment?

$$I_t^d(\overset{-}{r_t^e}, \overset{?}{\delta}, \overset{+}{\theta}_{t+1}, \ldots.) = K_t(\overset{-}{r_t^e}, \overset{-}{\delta}, \overset{+}{\theta}_{t+1}, \ldots) - K_{t-1} + \delta K_{t-1}$$

Consider two different expected real interest rates $r_o^e < r_1^e$.

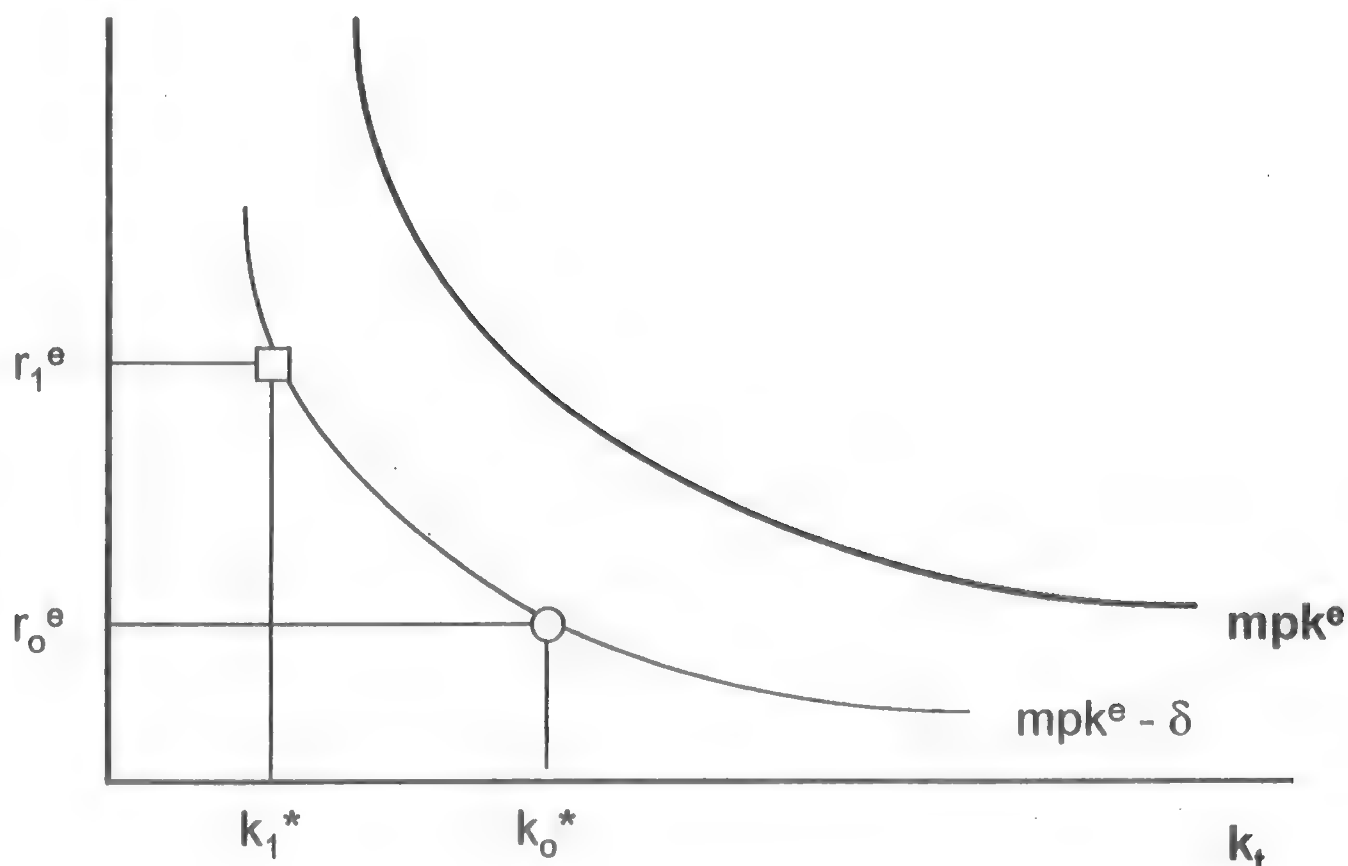


Figure X.4 Capital Decision

B. INTEGRATING INVESTMENT DEMAND INTO THE GOODS MARKET

The goods market clearing condition that the aggregate demand for goods in the economy (Y_t^d) equals the aggregate supply (Y_t^s) is now:

$$C_t^d + I_t^d = Y_t^s$$

and is pictured in Figure X.5.

Now we can see the important role that changes in *perceived* returns to investment, stressed by John Maynard Keynes, have in causing business cycle fluctuations. Suppose firms believe that there will be a technological innovation ($\theta_{t+1}\uparrow$). What are the impact (i.e. shift) effects?

a) The perceived increase in mpk_t raises I_t^d.

b) The corresponding improvement in mpn_t may induce workers to take more leisure today and work harder at t+1, implying a decrease in Y_t^s

c) The increase in wealth induced by expanded production opportunties may cause households to consume more at t, implying an increase in C_t^d

How do we see the effects graphically? See Figure X.6.

C. INVESTMENT AND THE BUSINESS CYCLE

What cyclical properties are implied by a perceived productivity shock?

a) Pro-cyclical real interest rates (contrast this to a current technology shock)

b) Pro-cyclical investment. You should note however that the increase in I_t^d induced by an increase in mpk_t (i.e. the shift) is somewhat offset by the decrease in I_t^d induced by the raised r_t (i.e. movement along the Y_t^d curve).

c) Pro-cyclical consumption. You should note however that the decrease in C_t^d induced by higher wealth (i.e. the shift) is somewhat offset by the decrease in C_t^d induced by the raised r_t (i.e. movement along the Y_t^d curve). Since the original shift was not large, (b) and (c) imply that consumption will be mildly procyclical and investment will be strongly procyclical.

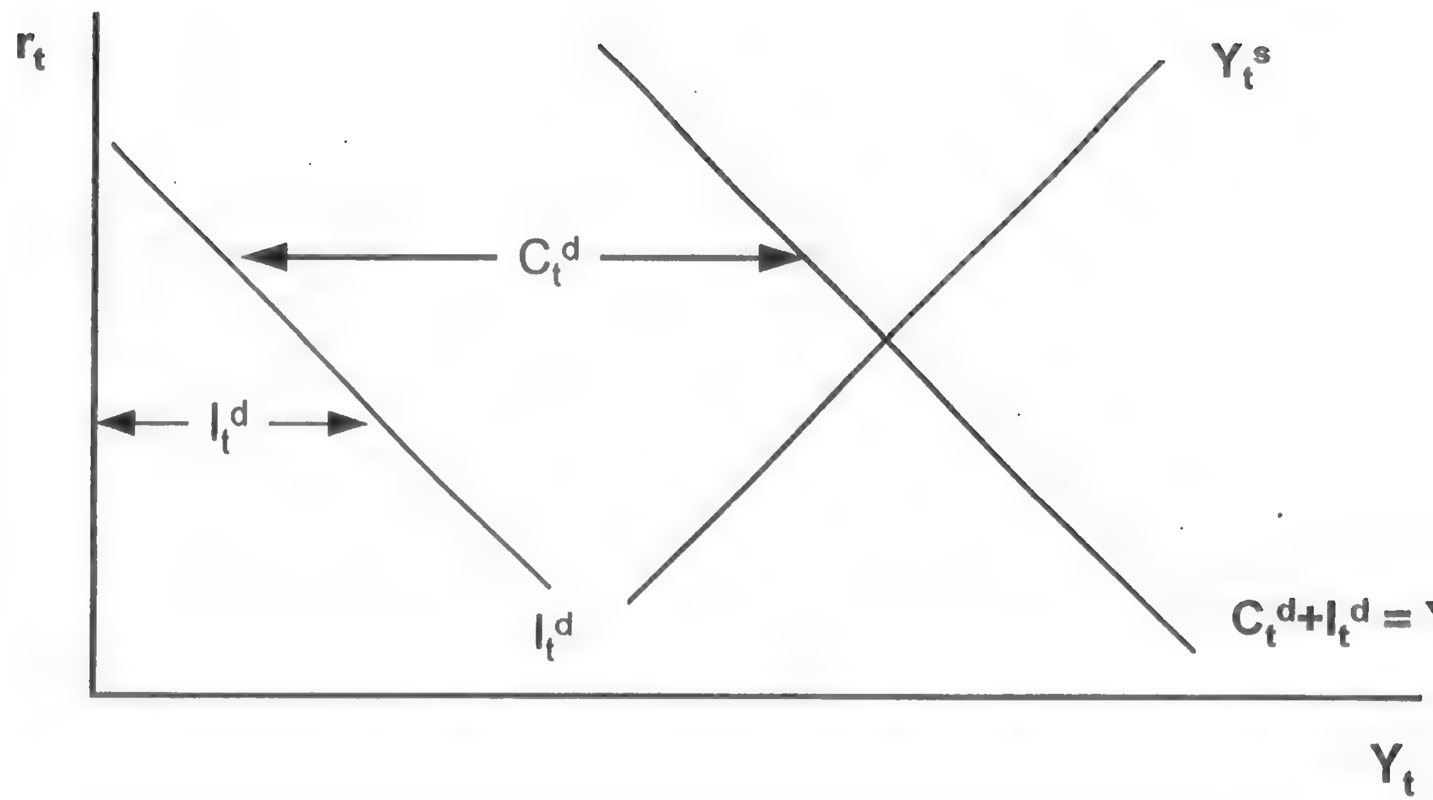


Figure X.5 The Goods Market with Investment

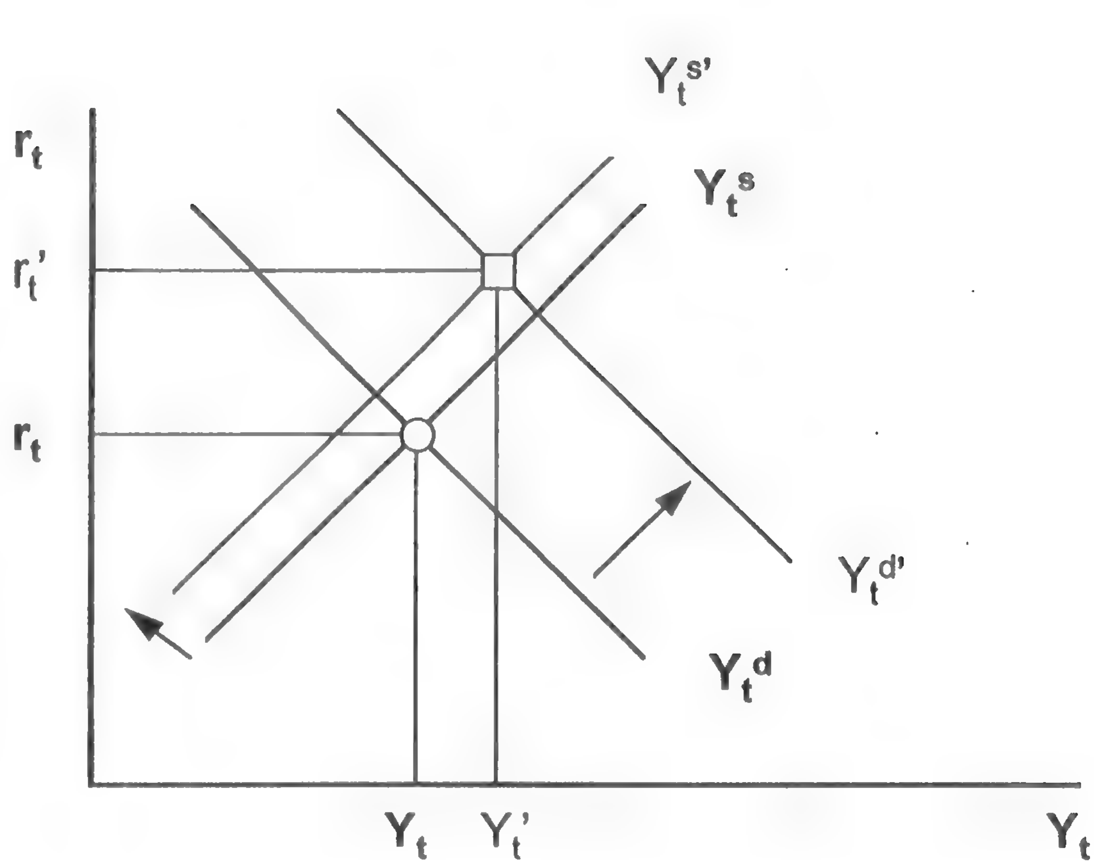


Figure X.6 Aggregate Responses to a Perceived Future Productivity Shock

d) Pro-cyclical labor hours. Despite the decrease in n_t^s induced through intertemporal substitution of leisure in response to the future high productivity state (i.e. the shift), there will be an offsetting increase in r_t (i.e. movement along the Y_t^s curve).

Note: This was meant to be another example of the role of expectations affecting current conditions.

D. SUMMARY

As in all of the decisions so far in our book, the economic agent (in this case the firm) demands capital to the point where the real cost of buying an additional unit of capital just equals its real benefit. If the firm finances its purchase of capital at the expected real interest rate, then this must equal its real benefit in terms of the expected additional goods it generates in the future net of its depreciation (i.e. firm j chooses k_t^j to the point where $r_t^e = mpk_t^e - \delta$). But this rule implies that if real financing costs are expected to rise (ie. the left hand side), then the demand for capital must fall (so that mpk_t^e on the right hand side rises as well). In this case, investment in capital goods is negatively related to the real interest rate.

Another important determinant of investment demand is firms' beliefs about future productivity. Because beliefs can be very volatile, Keynes termed this "animal spirits". If firms believe that capital will be very productive in the future (i.e. they expect θ_{t+1} to be high), then they will demand more capital today because it takes time to build. As aggregate demand for goods rises, this causes an increase in real output. This is another example of getting a boom today just because we believe there will be a boom tomorrow.

Chapter XI

FISCAL POLICY

Until now, we've concentrated on monetary policy. We've seen that while monetary policy has an important effect on inflation and nominal interest rates, our model predicts little effect on real quantities like output, consumption, investment, or real interest rates (recall the reasoning behind the classical dichotomy).

Now we concentrate on the other important branch of government macroeconomic policy which is undertaken by fiscal authorities. While monetary policy deals with the supply of commercial bank reserves (in an attempt to ultimately influence the money supply), fiscal policy deals with:

(a) Government expenditure
(b) How it finances this spending? That is, should it tax or borrow or rely on the creation of money (this is called seignorage)?

A. THE GOVERNMENT BUDGET CONSTRAINT

We introduce the above two elements of fiscal policy by treating the government as we treated agents; the government spends subject to a budget constraint. The static budget constraint for the government is:

Nominal Expenditure = Nominal Receipts

or

$$P_t G_t + R_{t-1} B^g_{t-1} = P_t T_t + M_t - M_{t-1} + B^g_t - B^g_{t-1}$$

where

$G_t \equiv$ Total Government Real Expenditure Flow, which can be broken down into:

a) Government Purchases of Goods and Services
b) Transfer payments (social security, unemployment insurance,...)

$T_t \equiv$ Total Government Real Taxation Flow, which comes from:

a) Individual Income Taxes
b) Corporate Profits Tax

c) Excise, Customs Duties,...
d) Social Insurance Levies

M_t ≡ Nominal Stock of Government Supplied Money

B^g_t ≡ Nominal Stock of Government Supplied Bonds. You should interpret B^g_t as the nominal debt or obligation of the government, so that unlike the individual where $P_t b_t > 0$ is an asset (the stock of nominal private bonds), $B^g_t > 0$ is debt by definition.

We can rewrite the static budget constraint as:

$$B_t^g - B_{t-1}^g \;(\equiv \text{Nominal Government Deficit}) = P_t G_t + R_{t-1} B_{t-1}^g - P_t T_t - (M_t - M_{t-1})$$

which states that the change in nominal government debt (that part of the deficit financed by issuing bonds) is simply the difference between nominal government expenditure (including nominal interest payments on past debt) and nominal revenues coming from taxation and money creation.

To get the real government deficit we simply divide through by the price level. The difference between the real and nominal deficits is high when inflation is high. Inflation reduces the value of government debt obligations (a pretty good reason for the government to increase inflation).

B. SOME OBSERVATIONS ON THE DATA

Figure XI.1: Government Expenditure as a fraction of GNP. This is the part of the government budget constraint associated with $G_t + R_{t-1}B^g_{t-1}/P_t$. Notice a steady rise in total expenditure and a steady decline in government purchases. The difference is due to the rise in transfers and interest payments.

Figure XI.2: Government Receipts as a fraction of GNP. This is the part of the government budget constraint associated with $T_t + (M_t - M_{t-1})/P_t$. Notice a steady rise in this measure of the overall tax rate. The components of government receipts can be broken down into: income taxes (which have remained a relatively stable share of receipts since WWII ($\approx$ 42%)), corporate profit taxes (which have declined steadily to $\approx$ 7% of receipts), social insurance taxes (social security, unemployment taxes,... have increased substantially as a share of total receipts since WWII from 10% to 42%), custom and excise taxes (which have fallen to 7% of receipts), and revenue from money creation (a minimal 2% of receipts).

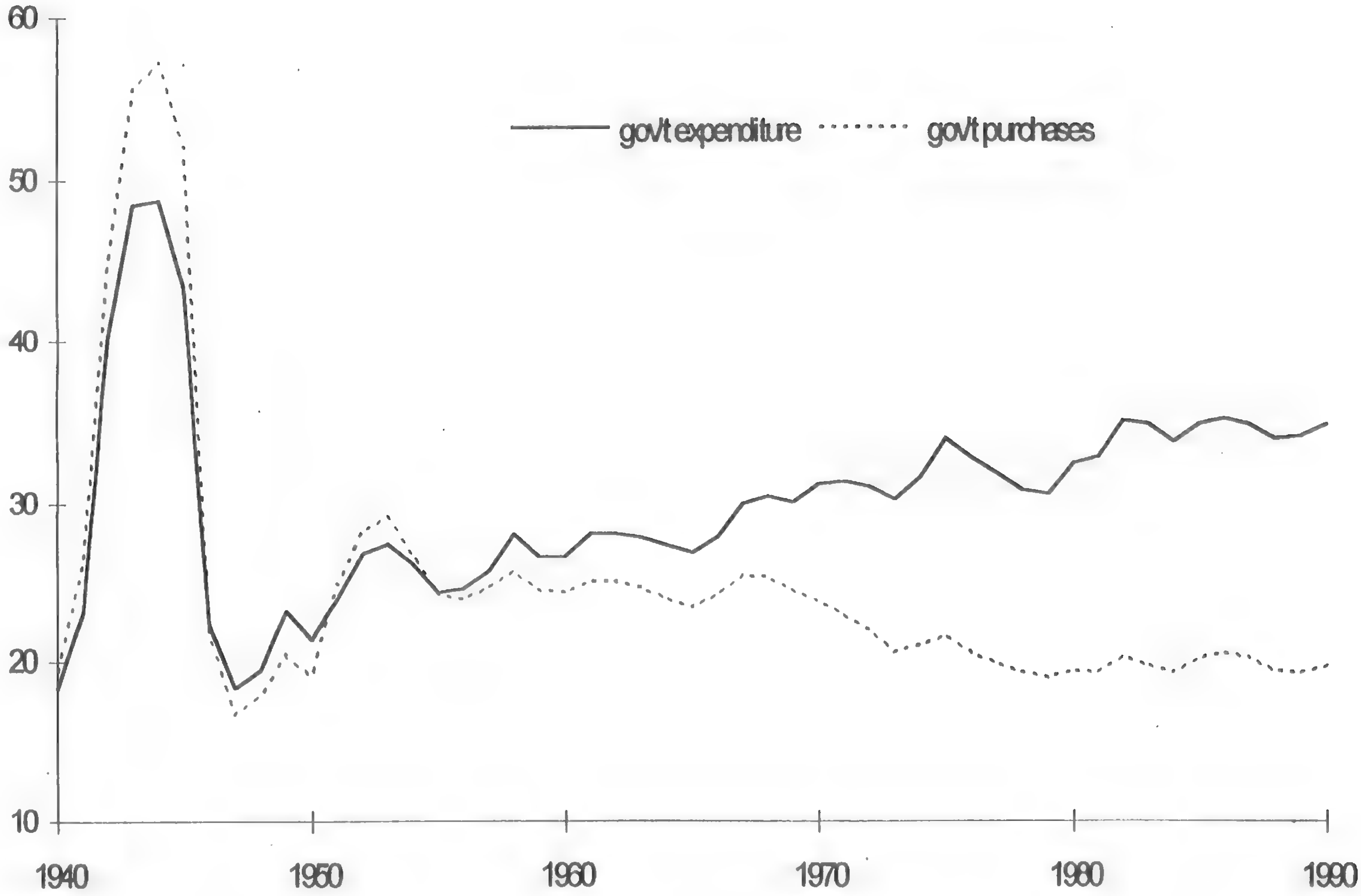


Figure XI.1 Gov't Expenditure and Gov't Purchases Over Output

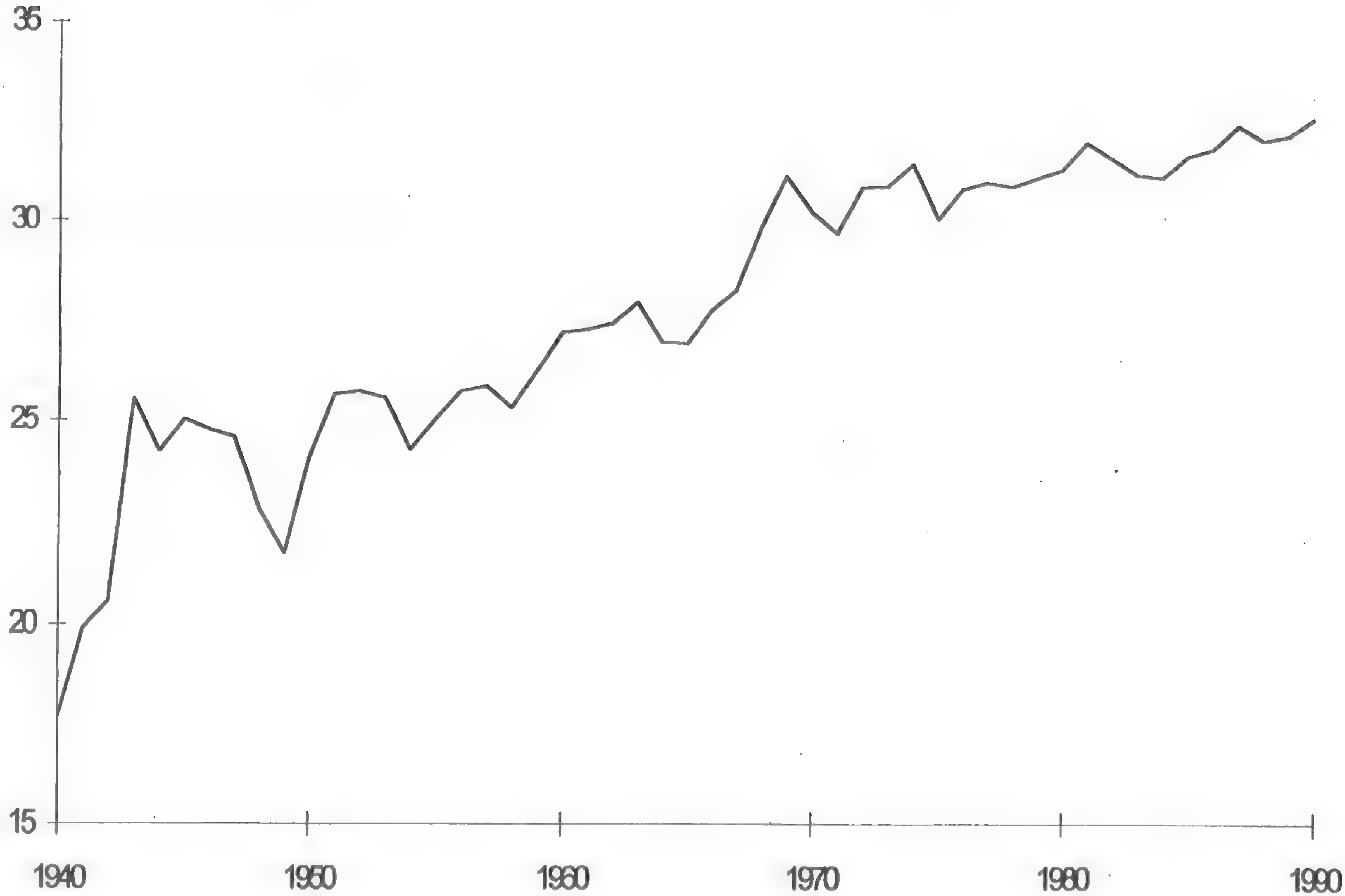


Figure XI.2 Government Receipts/Output

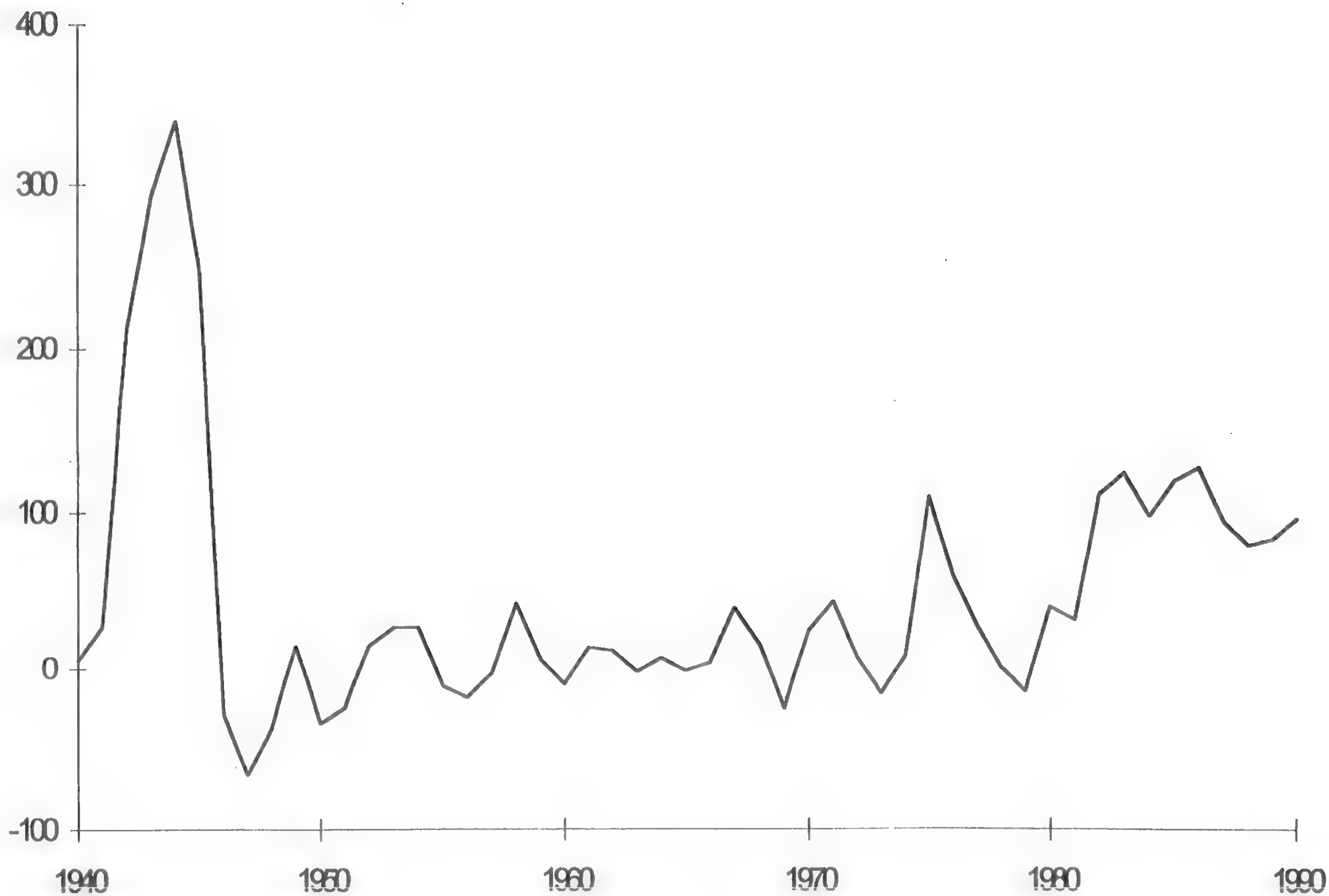


Figure XI.3 Govenment Real Deficit

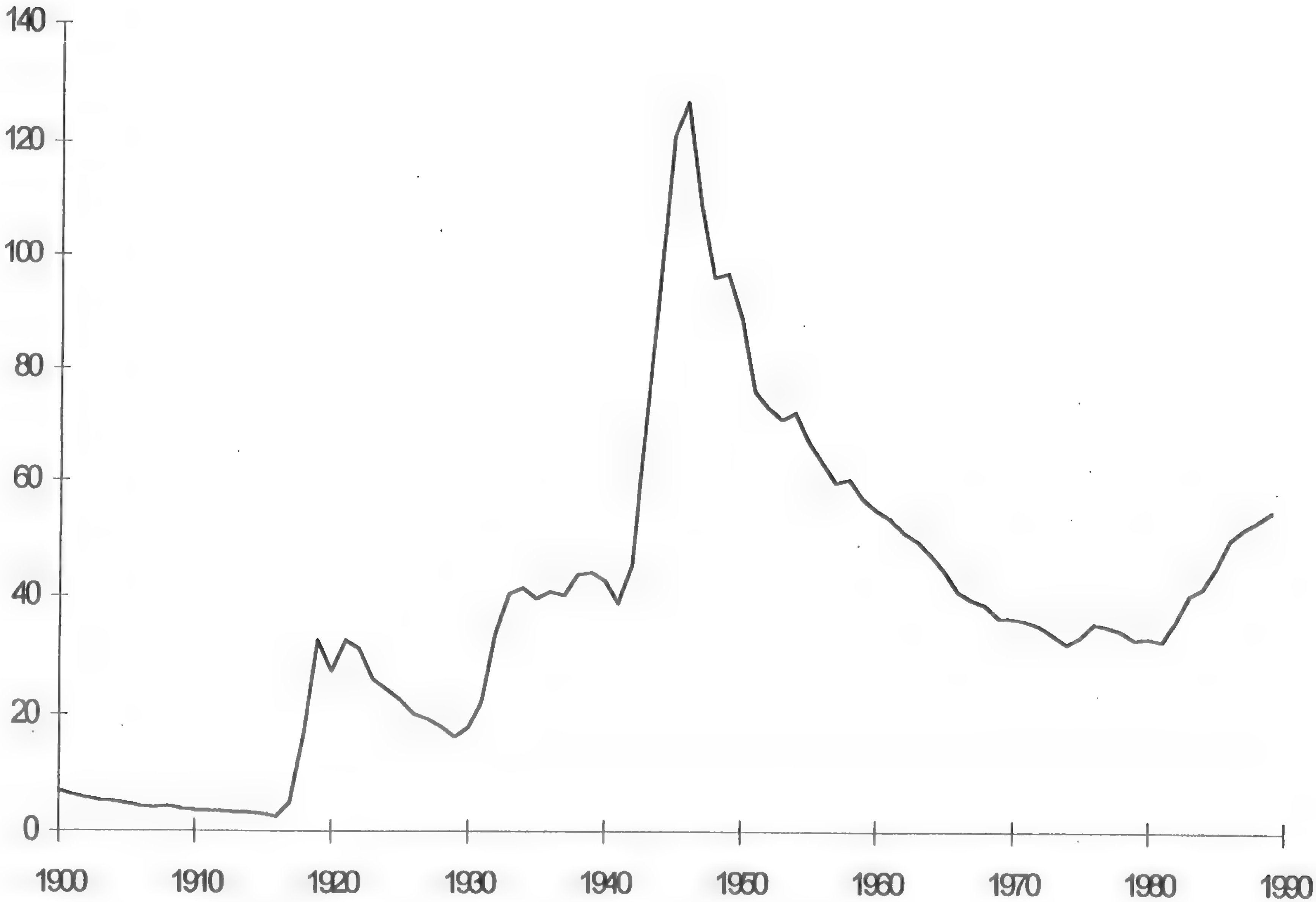


Figure XI.4 Government Debt/Output

Figure XI.3: U.S. Debt as a fraction of GNP. This is the part of the budget constraint associated with the stock B_t^g. Notice the sharp buildups and declines around wartimes as well as the sharp buildup after 1980.

Figure XI.4: Real Deficit. This is the part of the budget constraint associated with the flow $(B_t^g - B_{t-1}^g)/P_t$.

C. THE TIMING OF TAXES AND RICARDIAN EQUIVALENCE

Just as we expressed the sequence of static budget constraints for a household as one intertemporal budget constraint where the present discounted value (PDV) of expenditure = PDV of receipts, we can do the same thing for the government. If we rewrite the static government budget constraint at t and t+1 in real terms we have:

$$G_t - T_t = b_t^g - (1+r_{t-1})b_{t-1}^g + m_t - \frac{m_{t-1}}{1+r_{t-1}}$$

and

$$G_{t+1} - T_{t+1} = b_{t+1}^g - (1+r_t)b_t^g + m_{t+1} - \frac{m_t}{1+r_t}$$

where $b_t^g \equiv B_t^g/P_t$ and $m_t \equiv M_t/P_t$.

For simplicity, suppose we assume there was no initial debt or money issued by the government, then solving for b_t^g in the second equation and plugging it back into the first we have:

$$G_t + \frac{G_{t+1}}{1+r_t} = T_t + \frac{T_{t+1}}{1+r_t} + \frac{R_t m_t}{1+R_t} + \frac{b_{t+1}^g + m_{t+1}}{1+r_t}$$

which says that the PDV of government expenditure must equal the PDV of tax revenue, the flow revenue from money creation, and the PDV of future obligations.

If we had extended this to many, many periods then the PDV of future obligations would go to zero provided the government wasn't in infinite debt. Since the revenue from money creation is small in the U.S. (as opposed to countries like Argentina), we can rewrite the government intertemporal budget constraint as:

$$\sum_{j=0}^{\infty} \left[\frac{1}{1+r}\right]^j G_{t+j} = \sum_{j=0}^{\infty} \left[\frac{1}{1+r}\right]^j T_{t+j}$$

assuming constant real interest rates.

What if the government decreases taxes today without decreasing government expenditure today by the same amount? The intertemporal budget constraint says that if the PDV of govt expenditure doesn't change, then households should recognize that taxes will have to be raised in the future.

If that is true, does the timing of taxes matter? Suppose that taxes were lump sum (independent of how much you work, consume, save, etc. This quite unrealistic assumption implies that taxes do not distort work effort, savings behavior, etc.). In that case, since the PDV of the government's tax revenues didn't change, the PDV of your after-tax income shouldn't change. But then your consumption shouldn't change. Summing over all individuals, if Y_t^s and C_t^d don't change, then interest rates shouldn't change. Magic, huh? The theory says the individual would save all of the tax cut in order to pay off her future tax burden.

We can see this graphically with the aid of the Fisher Diagram in Figure XI.5. All that changed was the timing of taxes not the PDV of them. Hence the receipts side of the intertemporal budget constraint does not change in the Fisher Diagram. Since preferences don't change, consumption doesn't change. The agent simply saves more.

This has implications for the bond and goods markets. The bond market is now expanded to include the supply of government bonds (assumed to be perfect substitutes for private bonds). See Figure XI.6. Since G_t is unchanged, but T_t decreases, the government runs a deficit in period t. To finance the deficit, the government issues bonds (i.e. government borrowing rises in the bond market). But since we showed that households want to save more, there's no increase of r_t in response to government borrowing. Also since Y_t^s, C_t^d, and G_t are unchanged, the goods market diagram is unchanged.

To summarize, newspapers or politicians often argue that government deficits compete with the private sector for funds, which drives up real interest rates and *crowds out* investment. The analysis above calls this argument into question. This counter intuitive result dates back to David Ricardo (1772-1823) and is called the *Ricardian Equivalence Theorem* (RET).

<u>Definition:</u> The *RET* states that if taxes are lump sum, changes in the timing of taxes with no change in the pattern of government spending do not affect the economy.

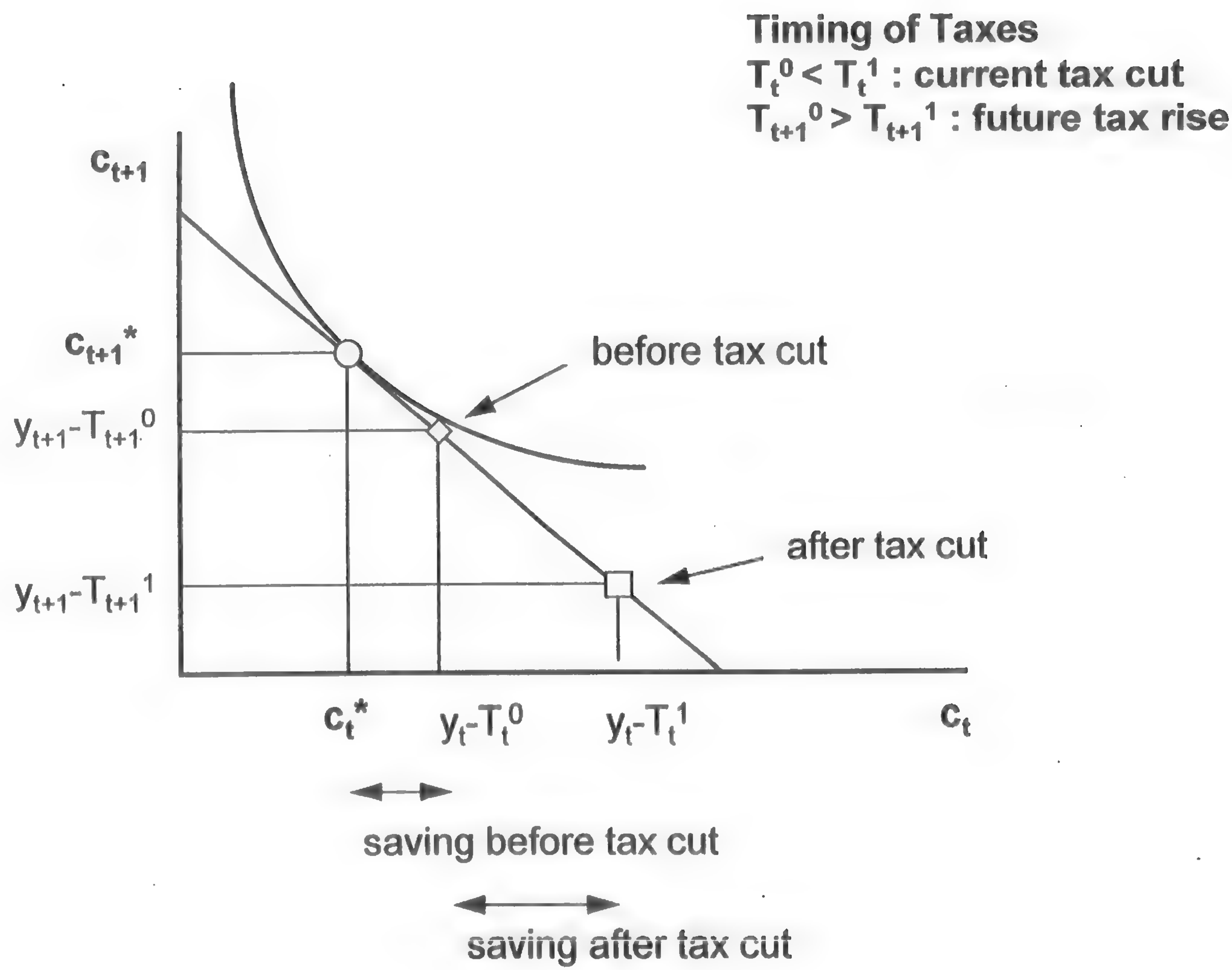


Figure XI.5 Fisher Diagram

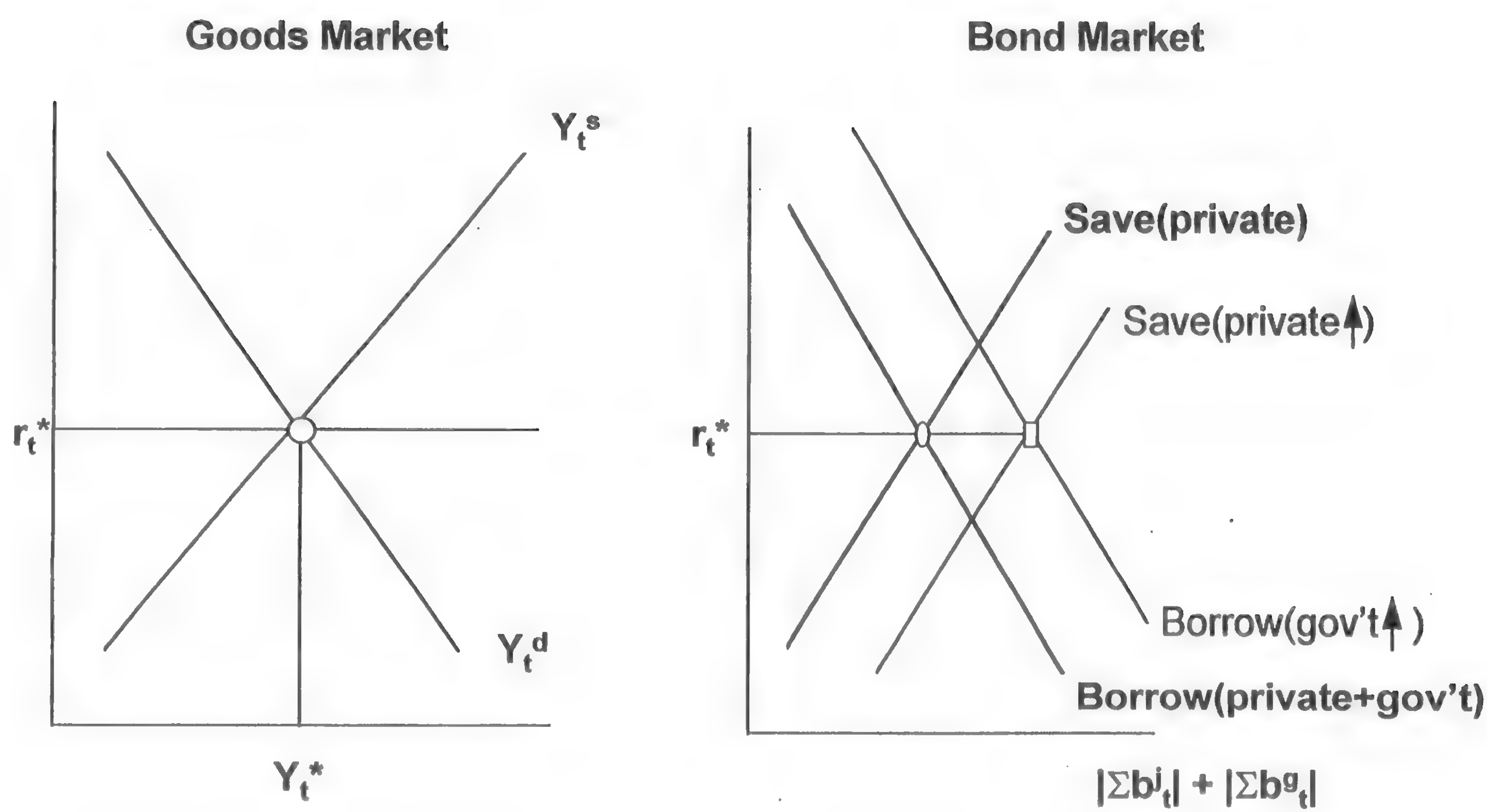


Figure XI.6 RET: A Change in the Timing of Taxes

Problems with the RET: Individuals do not live forever (i.e. they have finite lives). The government of the U.S. has been around for over 200 years. Since I have a lifetime that is shorter than the life of the government, if the government cuts taxes now and raises them after I'm dead, the PDV of *my* disposable income is higher even though the PDV of government tax revenue has not changed.

For example, suppose I live for 2 periods but the government lives for 3. Suppose government cuts my (lump sum) taxes by \$100 today. With no change in government expenditure, in order to satisfy its intertemporal budget constraint the government has two options.

a) increase taxes by \$100 $(1+R)$ at $t+1$.
b) increase taxes by \$100 $(1+R)^2$ at $t+2$.

What happens to the PDV of *my* tax bill in both cases:

a) $-\$100 + \dfrac{\$100(1+R)}{(1+R)} = 0$ (i.e. no change)

b) -\$100 (i.e. my tax bill falls by \$100)

It is only in case (b) that my consumption behavior changes. That is, the RET may not hold in the case where I die before the tax increase is levied.

Resurrecting the RET: In case (b), what if I love my children so much that I don't want them to be burdened by the $t+2$ tax increase? That is, I leave a bequest of $\$100(1+R)^2$ at $t+2$ in my will (arrived at by saving the initial tax cut). In this case my consumption behavior does not change. To conclude, if I'm altruistic in this way, then even finite lifetimes do not invalidate RET.

D. GOVERNMENT PURCHASES

It's important to know what the RET is not saying. It is not saying that a change in the deficit induced by a change in government purchases (or even its timing) has no real effects. So now we study how changes in G_t affect real decisions. From what we know about the RET, it doesn't matter whether the increase in G_t is financed by a current increase in lump sum taxes (T_t) or by issuing bonds at t and raising future lump sum taxes (T_{t+j}).

Temporary Government Expenditure: Consider a temporary balanced budget increase in G_t (i.e. T_t rises by the same amount as G_t).

The goods market clearing condition with G_t is now:

$$C_t^d(\overset{-}{r_t};\overset{-}{T_t},\ldots) + I_t^d(\overset{-}{r_t};\ldots) + G_t = Y_t^s(\overset{+}{r_t};\overset{+}{T_t},\ldots)$$

In this case, the effect of a temporary increase in G_t and T_t is (see Figure XII.7):

(a) C_t^d decreases due to income effect of the rise in T_t
(b) Y_t^s increases due to income effect of the rise in T_t. That is, the decrease in after-tax income → decreased spending on leisure. The increase in Y_t^s is special to the *lump sum tax* assumption - there are no substitution effects present in this case.

What happens to the composition of equilibrium output?

(a) consumption: falls due to income effect of increased T *and* substitution effect of increased r_t

(b) investment: falls due to higher real financing cost (increased r_t).

An important observation of this experiment - a temporary increase of G_t - is that government spending *crowds out* private expenditure (C_t and I_t fall).

Next, consider the effects on the price level. We must examine the money market (also in Figure XI.7). The temporary increase of G_t increases r_t and decreases C_t → decrease of M_t^d. The excess supply of money at the old prices P_t puts upward pressure on prices until P_t'.

We have made the assumption that government purchases of goods and services do not provide utility to households and are not an input into private production. Clearly government spending on law enforcement, transportation, and education substitutes for private spending and yields utility and productive benefits. Taking this into account would simply magnify the effects of the decrease in C^d and the increase in Y^s. This wouldn't change the above qualitative results, only its quantitative results (e.g. r_t wouldn't rise as much).

Permanent Government Expenditure: The PDV of the tax burden associated with a permanent increase in government expenditure rises significantly. The income effect of this

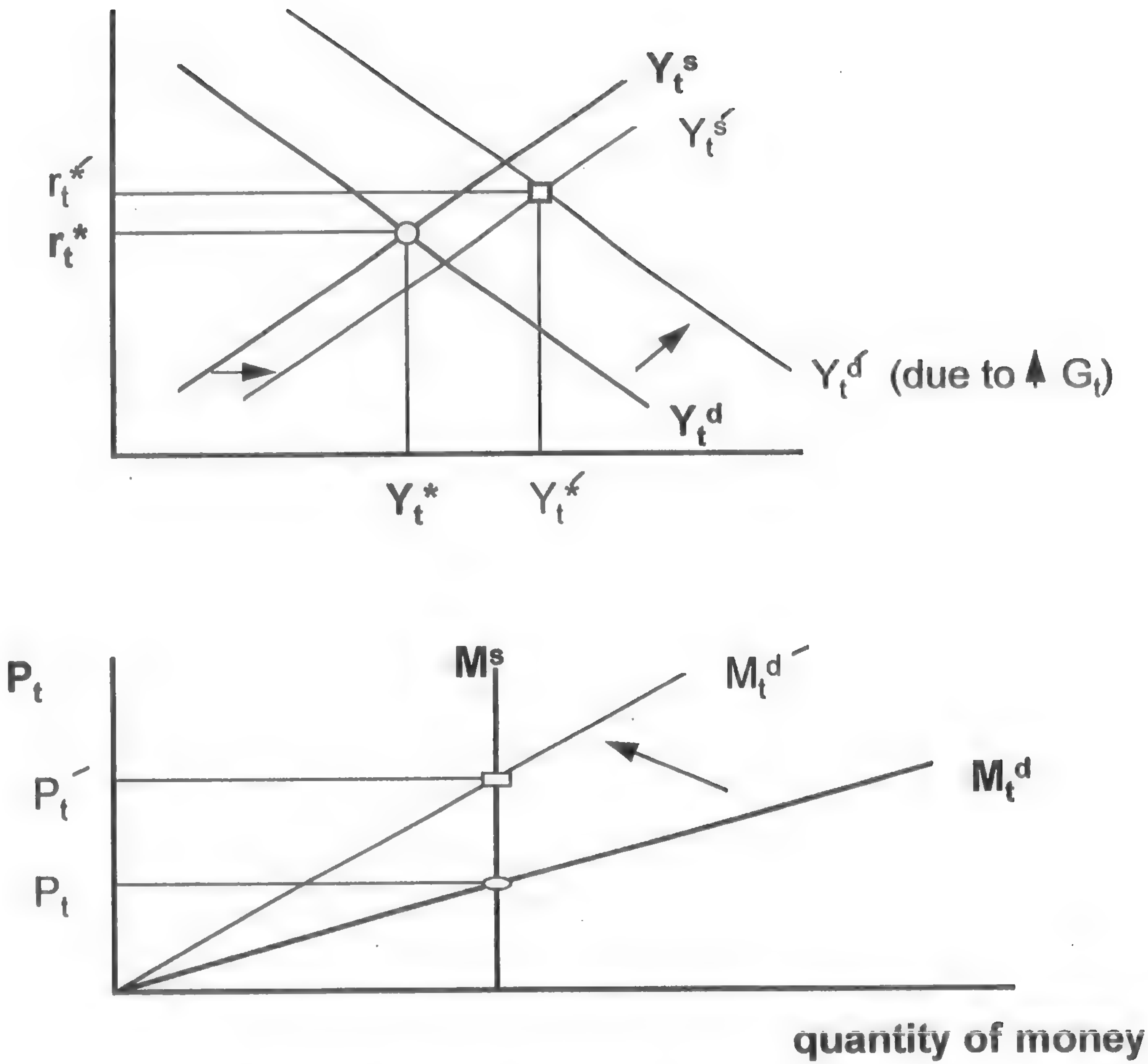


Figure XI.7 Goods and Money Market Reactions to Temporary Increase in G

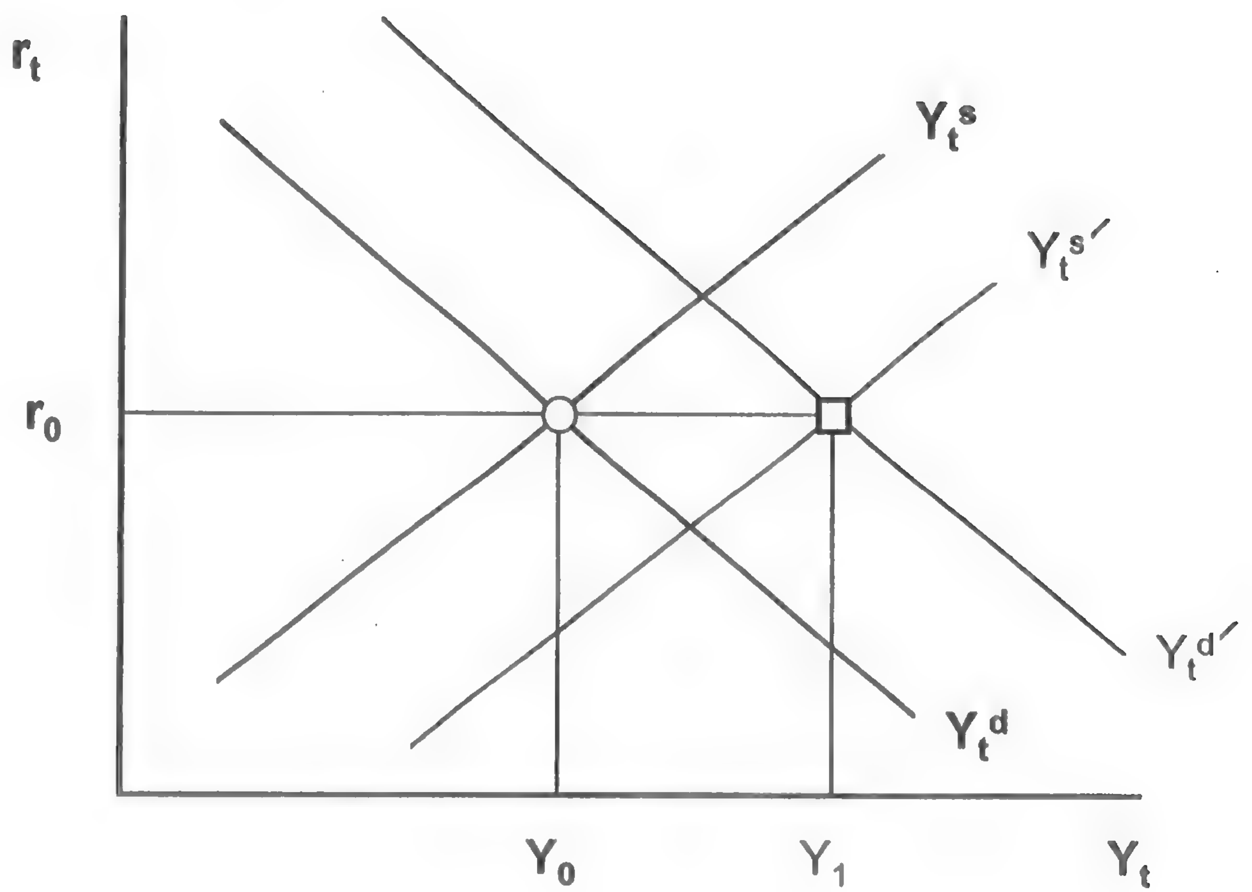


Figure XI.8 Permanent Increase in Government Expenditure

decline in wealth leads to a decrease in consumption of goods and leisure ($\rightarrow$ increase of labor supply). See Figure XI.8.

The composition of output in response to a permanent increase in government expenditure is somewhat different from the temporary case. In particular, while C_t decreases, I_t is unchanged since real interest rates are unchanged.

E. DISTORTIONARY TAXATION

Until now, we've considered lump sum taxes that do not distort the "margins" of economic behavior. While non-distortionary lump sum taxes are the economist's preferred means of revenue creation, and while they've simplified our analysis so far (i.e. they have only income effects rather than substititons effects), they are not realistic. Most real world taxes distort the behavior of workers (income and social security taxes), savers (capital gains taxes), consumers (sales taxes), etc.

Distortionary Wage Taxes: To see the difference between lump sum and marginal taxes, consider the decision of how much labor to supply illustrated in Figure XI.9. Notice that with lump sum taxes, labor effort *rises* with an increase in taxes (only the income effect is operative). With marginal income taxes, however, labor effort *falls* with an increase in taxes (since the substitution effect is present and dominates).

Distortionary Effects on Firms: To see how marginal taxes can affect firm behavior, consider corporate profit taxes (which depend on various tax credits and on the rules for computing depreciation allowances and valuing inventories) and the decision to invest. Recall, a firm demands capital to the point where marginal cost of the investment is equal to the marginal benefit, or in real terms

$$1 + r(1 - \tau) = (1 - \tau^f)\,\mathrm{mpk} + (1 - \tau^f)(1 - \delta)$$

Notice that the tax burden from investing is given by:

$$\tau^f\,\{\mathrm{mpk} + 1-\delta\}$$

So now we see how accelerated depreciation lowers the tax burden and can spur on more investment. Also we see how investment tax credits (a decrease of τ^f) raise the demand for capital. As before, an increase in the after-tax real interest rate, by raising the marginal cost of investing, lowers the demand for capital.

In general,

$$I_t^d\ (\overset{-}{r}(1-\tau), \overset{-}{\tau}^f, \ldots)$$

The Effects of Distortionary Taxes on the Macro Economy:

a) Consider a permanent increase in marginal tax rates (to retire past debt) with no change in government spending. See Figure XI.10.

. Since the tax is not on leisure, people work less and aggregate supply falls.
. Since the PDV of after tax income falls, households consume less.
. Since the return to investment falls, firms demand less capital.

b) Reconsider the Ricardian Equivalence Theorem. It said that the timing of taxes didn't affect real variables like r_t, Y_t. That is, since the PDV of tax obligations didn't change *and* taxes didn't distort behavior, there was no reason to alter one's labor supply or consumption decision. In that case, the goods market diagram would be unchanged. With distortionary taxes however, things change. In this case, even though the PDV of tax obligations won't change, if income taxes fall today you'll take advantage of it and supply more labor currently → increasing Y^s. Furthermore, as long as the tax rise is far enough in the distant future, then the firm's capital may be so depreciated as to make the tax burden associated with that capital non-existent, and so current investment would rise as current corporate taxes fall → increase in I^d. In this case the goods market diagram is given by Figure XI.11 (compare this to Figure XI.6). Now, the timing of taxes matters.

F. SUMMARY

In this chapter we studied fiscal policy; that is, government expenditure and financing policies (through taxation and/or borrowing). Similar to an individual, the government is subject to a budget constraint which states that government expenditure plus interest payments on the national debt must equal its tax revenue, any new money it issues, and its issue of new government debt. As in the case of an individual, issuing debt is not a long-term solution. Eventually, the debt must be paid back through tax revenues or money creation (countries like interwar Germany or Argentina used the latter approach of money creation). Since money issue as a means of financing government expenditure is not important in the U.S., the intertemporal budget constraint for the government is simply that the present discounted value of all future government expenditure must equal the present discounted value of all future tax revenues.

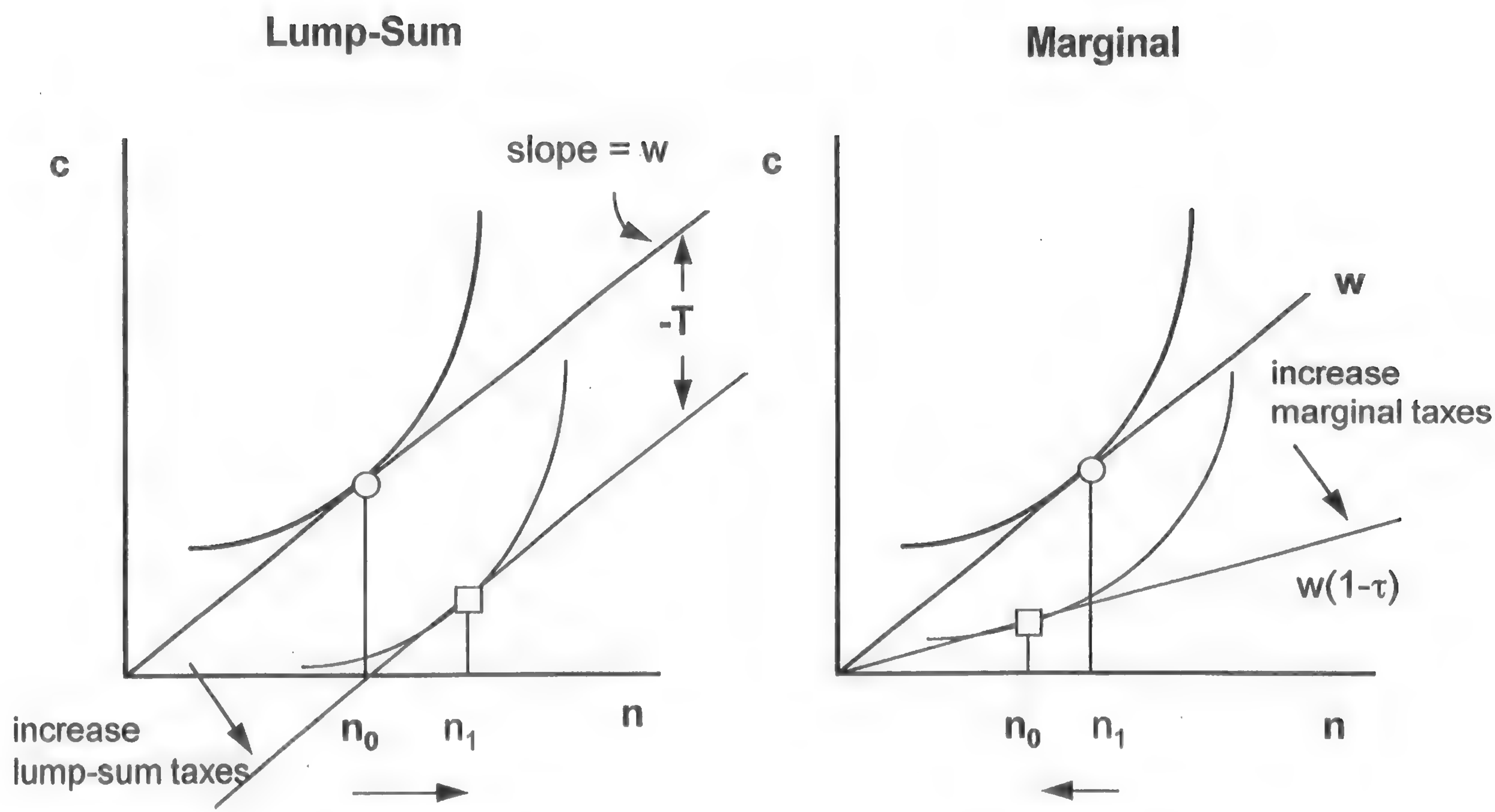


Figure XI.9 Labor Supply Decision: Lump-Sum and Marginal Taxes

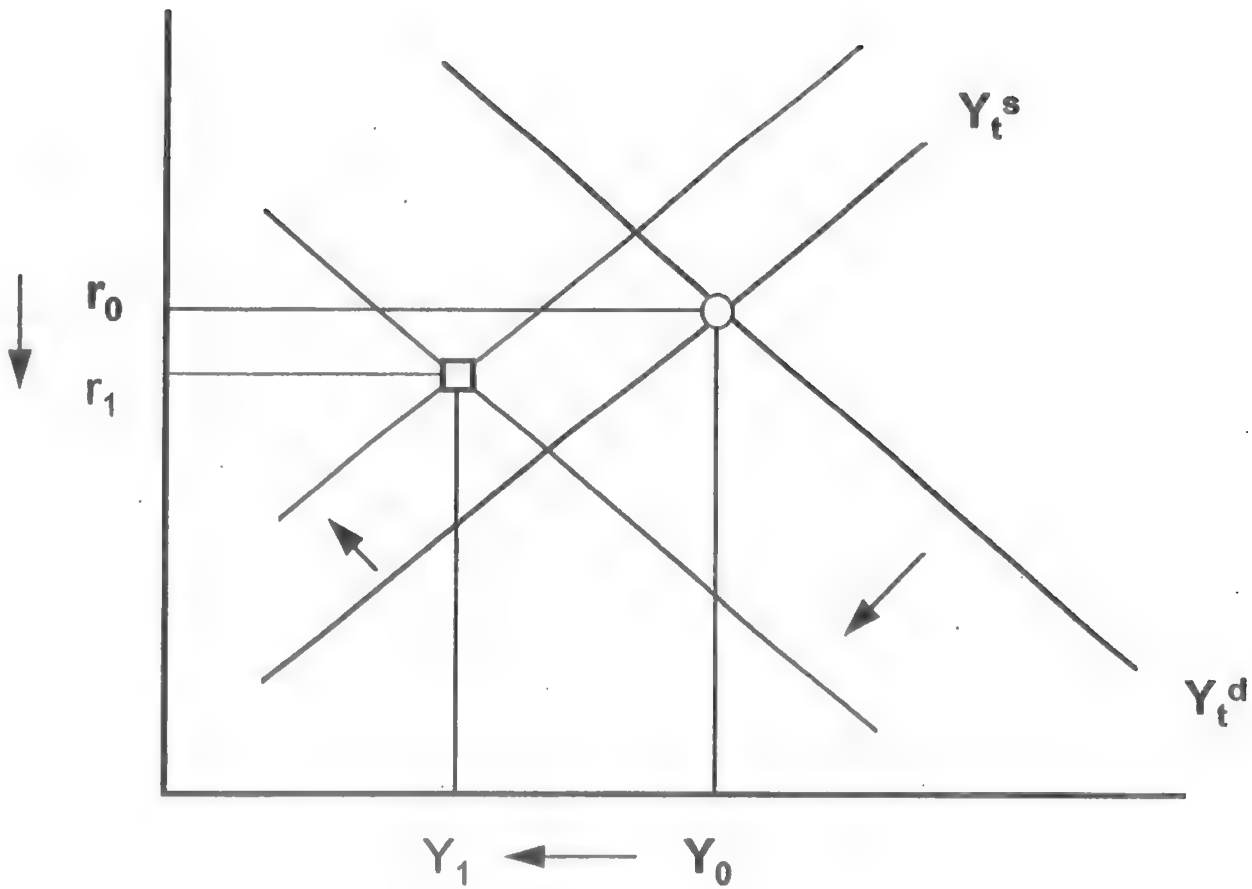


Figure XI.10 Permanent Increase in Marginal Tax Rates

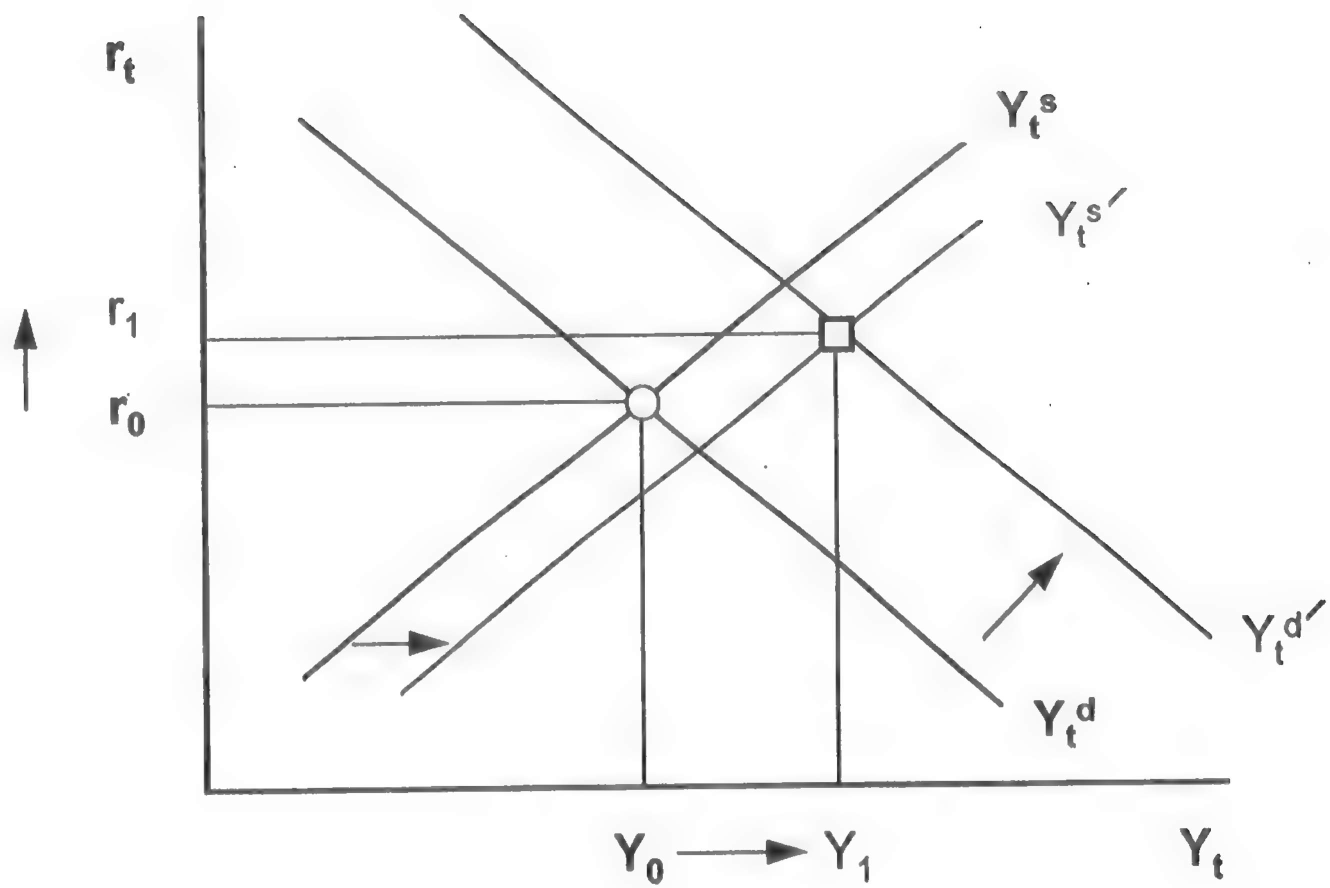


Figure XI.11 The Effects of Distortionary Taxes

In that case, does the timing of taxes matter? That is, does low current taxation, which by the government's intertemporal budget constraint must mean high future taxation, alter real interest rates and output? Low current taxes relative to government expenditure must be financed by government borrowing today. Does this excessive government borrowing raise real interest rates? If agents realize that they will be taxed in the future, they may save in order to meet that future obligation. The increase in private saving mitigates the increase in government borrowing, so that real interest rates may not actually rise. This notion is summarized in the Ricardian Equivalence Theorem. We saw that the RET does not hold if finite lived agents are not altruistic or the government uses distortionary taxes.

Chapter XII

THE OPEN ECONOMY

Until now, we've considered an economy that didn't interact with the rest of the world; that is, a closed economy. This was a good characterization of the U.S. economy early in our history up to as recently as the 1950's (e.g. in 1954 the ratio of U.S. exports to GNP was 5%). Now we study an economy that interacts with the world in goods, credit and money markets; an open economy. This is a better characterization of the US economy recently (e.g. in 1991 exports/GNP = 10%).

A. DEFINITIONS AND IDENTITIES

Before analyzing the effects that opening up an economy has on interest rates and real output in an economy, we have to introduce some definitions.

A.1 Exchange Rates

Definition The *nominal exchange rate* ($\equiv e_t$) is the number of foreign currency units that trade for 1 domestic currency unit (here, we'll take that to be the $). That is, $e_t \equiv$ # foreign currency/1$.

Recall from your introductory economics class that the dollar price of apples, denoted P^A, is just the number of dollars that trade for 1 apple (i.e. P^A=#$/1 apple). We could have called this the relative price of apples in terms of dollars. In that case, an increase in P^A means apples become more expensive in dollar terms.

Exchange rates are just relative prices as well; the relative price of dollars in terms of foreign currency. By definition, if e_t increases, it takes more foreign currency to buy a dollar (i.e. the dollar *appreciates* relative to the foreign currency or becomes more expensive in foreign currency terms). Similarly, if e_t goes down, it takes less foreign currency to buy a dollar (i.e. the dollar *depreciates* relative to the foreign currency). A key to understanding movements in exchange rates is to recognize that trade in goods (and assets) necessitates trade in monies since money is the medium of exchange and the exchange rate is simply the relative price of two monies.

Definition The *real exchange rate* ($\equiv s_t$) is the number of foreign goods (or bundles of goods) that trade for 1 domestic good. That is,

$$s_t \equiv \frac{e_t P_t}{P_t^f} \equiv \frac{\dfrac{\#\text{foreign currency units}}{1\$} \bullet \dfrac{\#\$}{1 \text{ U.S. good}}}{\dfrac{\#\text{foreign currency units}}{1 \text{ foreign good}}} \equiv \frac{\#\text{ foreign goods}}{1 \text{ U.S. good}}$$

where P_t^f denotes the foreign currency price of a similar bundle of goods (i.e. the foreign CPI). Thus, the real exchange rate is just the relative price of U.S. goods in terms of foreign goods.

By definition then, if s_t rises, it takes more foreign bundles of goods to buy a given U.S. bundle of goods. The U.S. bundle is worth more (i.e. U.S. goods *appreciate* relative to foreign goods or become more expensive in foreign goods terms). Similarly, if s_t falls, it takes less foreign goods to buy a U.S. good (i.e. U.S. *depreciate* relative to foreign goods). Changes in real exchange rates can have an impact on the balance of trade.

A.2 Payments

Dufinition The (nominal) *current account* measures trade in goods and services. That is,

Current Account = Trade balance + Interest payments on net holdings of foreign bonds

or

$$\text{Current Account} = P_t\, Ex_t - P_t^f Im_t/e_t + R_{t-1}\, B_{t-1}^f/e_t$$

where

$Ex_t \equiv$ exports of U.S. real goods and services

$Im_t \equiv$ imports of foreign real goods and services

$B_t^f \equiv$ foreign bonds held by U.S. citizens - U.S. bonds held by foreigners. By definition, then, $B_t^f > 0$ means the U.S. is a net creditor and $B_t^f < 0$ means the U.S. is a net debtor.

The first term (on the right hand side) measures foreign nominal expenditure on U.S. goods (they need dollars to purchase our goods). The second term measures the number of dollars that buy foreign goods. To arrive at that number, $P_t^f Im_t$ measures U.S. expenditure on foreign goods (we need foreign currency to purchase their goods). But since we want to measure this in *dollar terms* and $P_t^f Im_t$ is the number of *foreign currency units* needed to buy foreign goods, we must "deflate" by the exchange rate to put it in dollar terms. The third term is the dollar value of interest earned by U.S. citizens on their foreign holding of assets net of the interest we have to pay foreigners who hold some of our assets. The trade balance

(exports - imports) as a fraction of GNP between the U.S. and some of our trading partners (Germany, Japan, the U.K.) is given in Figure XII.1.

Definition The (nominal) *capital account* measures changes in the stock of assets across countries. That is,

$$\text{capital account} = B^f_t - B^f_{t-1}.$$

Definition The (nominal) *balance of payments* measures a country's trade in goods, as well as changes in its assets and stock of currencies. That is,

$$\text{balance of payments} = \text{current account} - \text{capital account}$$

or

$$X_t - X_{t-1} = P_t\, Ex_t - P^f_t Im_t/e_t + R_{t-1}\, B^f_{t-1}/e_t - (B^f_t - B^f_{t-1})/e_t$$

where

X_t $\equiv$ U.S. Central Bank Holdings of foreign exchange reserves (see Chapter VII where this was first defined).

Example Suppose the U.S. runs a current account deficit of \$10 billion (i.e. $P_t\, Ex_t - P^f_t Im_t/e_t + R_{t-1}\, B^f_{t-1}/e_t = -\$10$ billion). Since we purchase more foreign goods from abroad than we sell, foreigners won't give us goods for nothing. In exchange for goods, we need to give them IOUs. If the Fed doesn't accomodate this excessive expenditure, then private citizens in the U.S. must issue bonds exceeding bonds issued by foreigners by \$10 billion (i.e. $(B^f_t - B^f_{t-1})/e_t = -\$10$ billion). Then everything balances (i.e. 0 = -10 - (-10)). That is, since there's no change in Fed reserves, the trade deficit must be financed with an inflow of foreign savings.

Suppose that the trade deficit exceeded what foreigners were willing to accept of our IOUs (i.e. their savings inflow) by \$2 billion. Then the Fed would have had to supply extra foreign exchange to pay for the foreign goods. That is, the depletion of Fed reserves ($X_t - X_{t-1} = -2$) assures everything balances (i.e. -2 = -10 -(-8)).

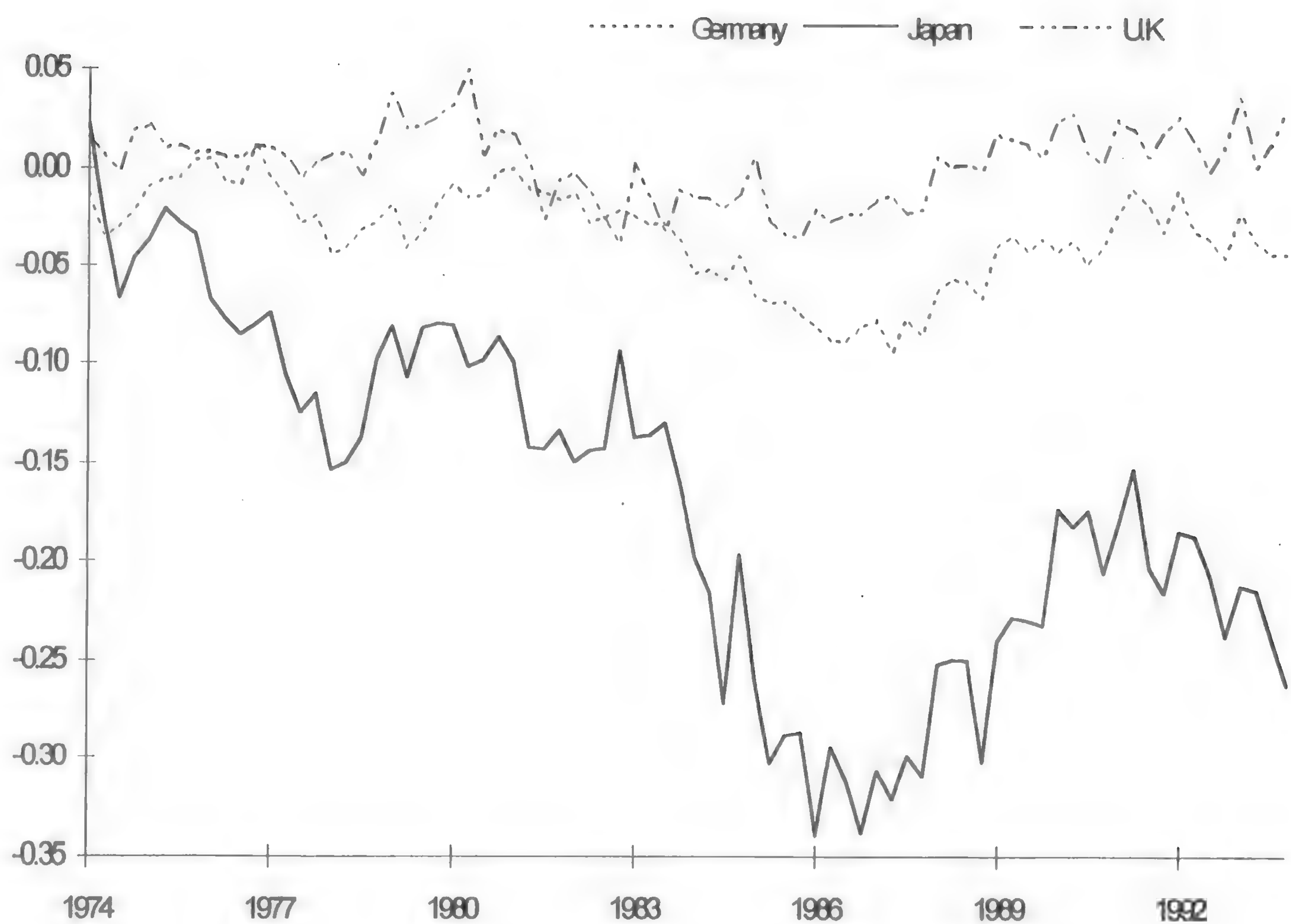


Figure XII.1 Trade Account Over GNP

<u>Definition</u> (Nominal) *GNP* equals (nominal) *Gross Domestic Product* (goods and services produced within our borders - denoted P_tY_t) plus net factor income from abroad.

$$P_t\, GNP_t = P_t\, Y_t + R_{t-1}\, B^f_{t-1}/e_t$$

Until this chapter, GNP=GDP because it was a closed economy and $B^f_t=0$ for all periods.

<u>Definition</u> The expenditure approach to GNP accounting implies

$$P_tY_t + R_{t-1}B^f_{t-1}/e_t = P_t(C_t + I_t + G_t) + \text{current account}$$

<u>Definition</u> In an open economy, the consolidated balance sheet of the Fed and Commercial Banks implies

$$M1_t = X_t + DC_t$$

This links accumulation of foreign currency reserves with supply of $ on the foreign exchange market. That is, if the Fed wants foreign exchange, it must supply dollars.

<u>A.3. The Market in Foreign Exchange</u>

Now we study the market in foreign exchange. The quantity variable is dollars. The price variable is e_t. The price e_t is determined by supply and demand in the foreign exchange market. U.S. agents supply dollars to obtain foreign currency in order to buy foreign goods and assets. Foreigners demand dollars in order to buy U.S. goods and assets. See Figure XII.2.

Why is Demand downward sloping? A decrease of e_t implies U.S. goods and assets are cheaper, so foreigners demand more U.S. goods and assets (and need dollars to purchase them). A "substitution" effect.

Why is Supply upward sloping? This isn't so clear because there are two competing effects when e_t rises. The supply curve slopes up only if "substitution" effects dominate "valuation" effects.

(a) *"Substitution" effect*: An increase in e_t implies foreign goods and assets are cheaper, so U.S. citizens demand more foreign goods and assets (and supply dollars in order to obtain the foreign currency). This provides the reason for the upward slope.

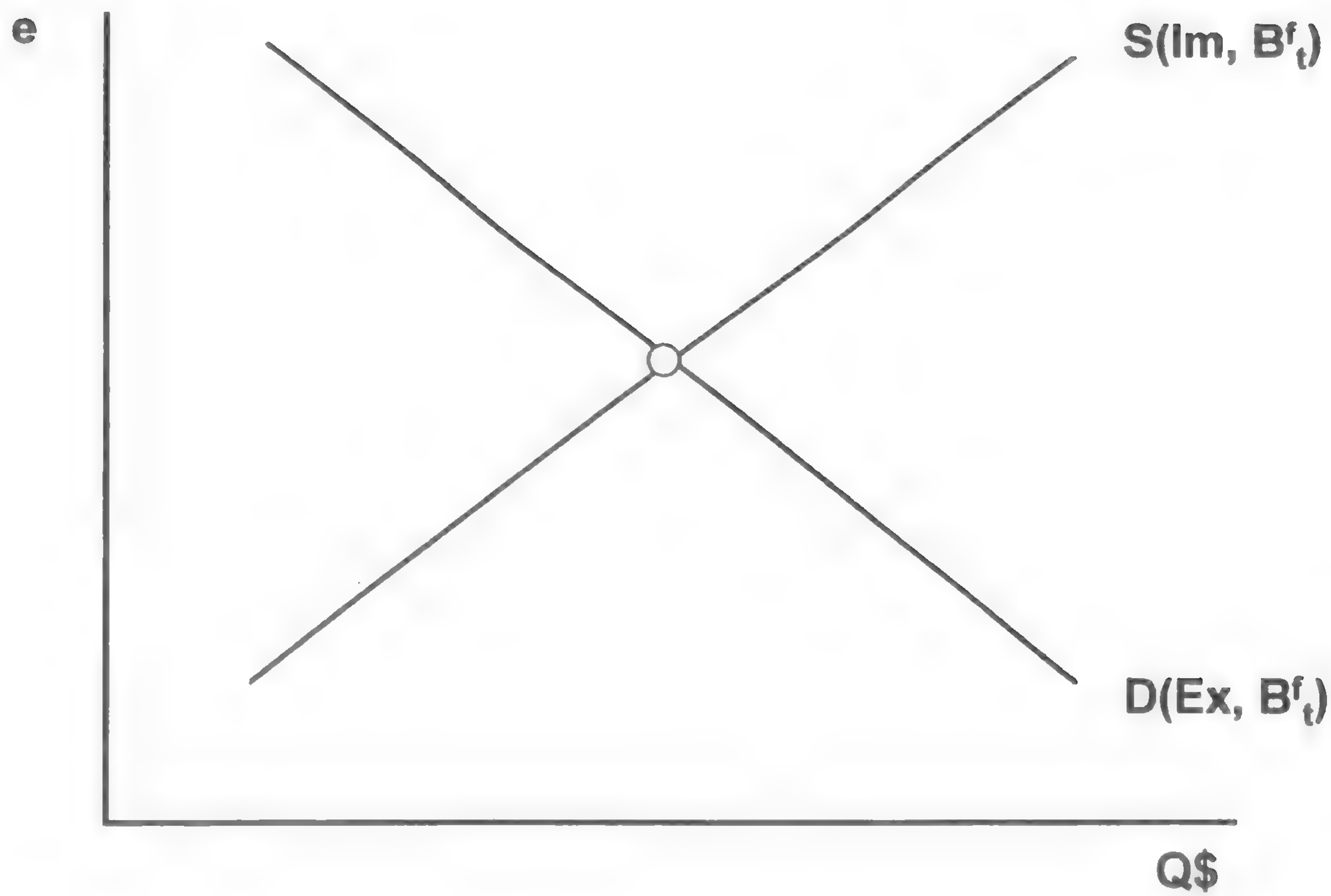


Figure XII.2 Foreign Exchange Market

(b) *"Valuation" effect*: Every dollar buys more foreign currency anyway. So U.S. citizens don't need to supply as many dollars to get the foreign goods and assets. This can be seen in the above current and capital account definitions since we "deflate" by e_t. This effect would generate a downward sloping supply curve.

We typically assume "substitution" effects dominate "valuation" effects.

A.3. Types of Exchange Rate Systems

Definition In a *flexible* exchange rate system, Central Banks are not required to stabilize the exchange rate in response to shocks.

For example, suppose U.S. nominal interest rates (R) increase (ceteris paribus) and foreigners want to save in the U.S. (See Figure XII.3) Foreigners need dollars to buy U.S. bonds and this implies an increase in demand in the foreign exchange market (from D^0 to D^1). In the absence of Fed intervention, this would appreciate the dollar (from e^0 to e^1).

Definition In a *fixed* exchange rate system Central banks stand ready to buy or sell reserves (intervene) in response to shocks to clear the market at the fixed price $\bar{e}$.

With regard to the above example, in response to the increased demand for dollars, with $\bar{e}$ fixed, the Fed must supply dollars (from S^0 to S^1) and receive foreign currency reserves of amount $Q'-Q=X_t-X_{t-1}$. See Figure XII.4.

There are two important points to note about fixed exchange rate systems. First, any increase of X_t implies an increase of M_t via the open economy definition of M1. That is, with fixed exchange rates, Central Banks lose control of their monetary policies.

This loss of control is what ultimately brought down the system of fixed exchange rates that existed until the early 1970's. Since the U.S. was experiencing inflation through the late 60's and early 70's, our goods were becoming less competitive. U.S. citizens wanted "relatively cheap" foreign goods and hence the supply of dollars in the foreign exchange market would rise (just an outward shift of the supply curve in Figure XII.5) putting downward pressure on e_t. The Fed had to support the dollars by buying them up (and selling its foreign exchange reserves) shifting supply back to its original point. When the Fed virtually ran out of reserves, the fixed exchange rate system died.

Second, how do we avoid the changes in M_t alluded to above? The Fed can follow a sterilization policy to change DC_t. That is, the impact of foreign reserve gains (losses) on

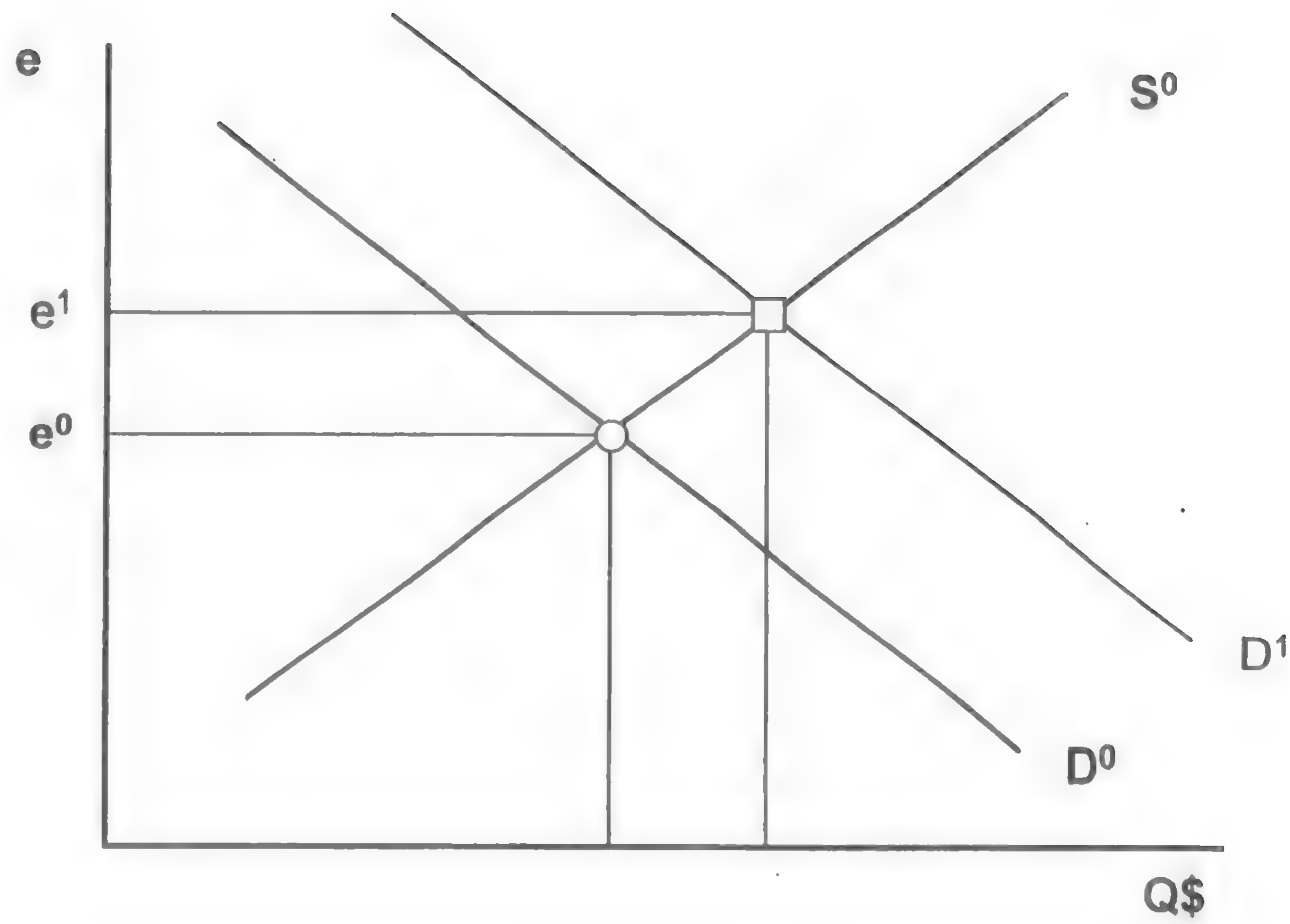


Figure XII.3 Flexible Exchange Rate System

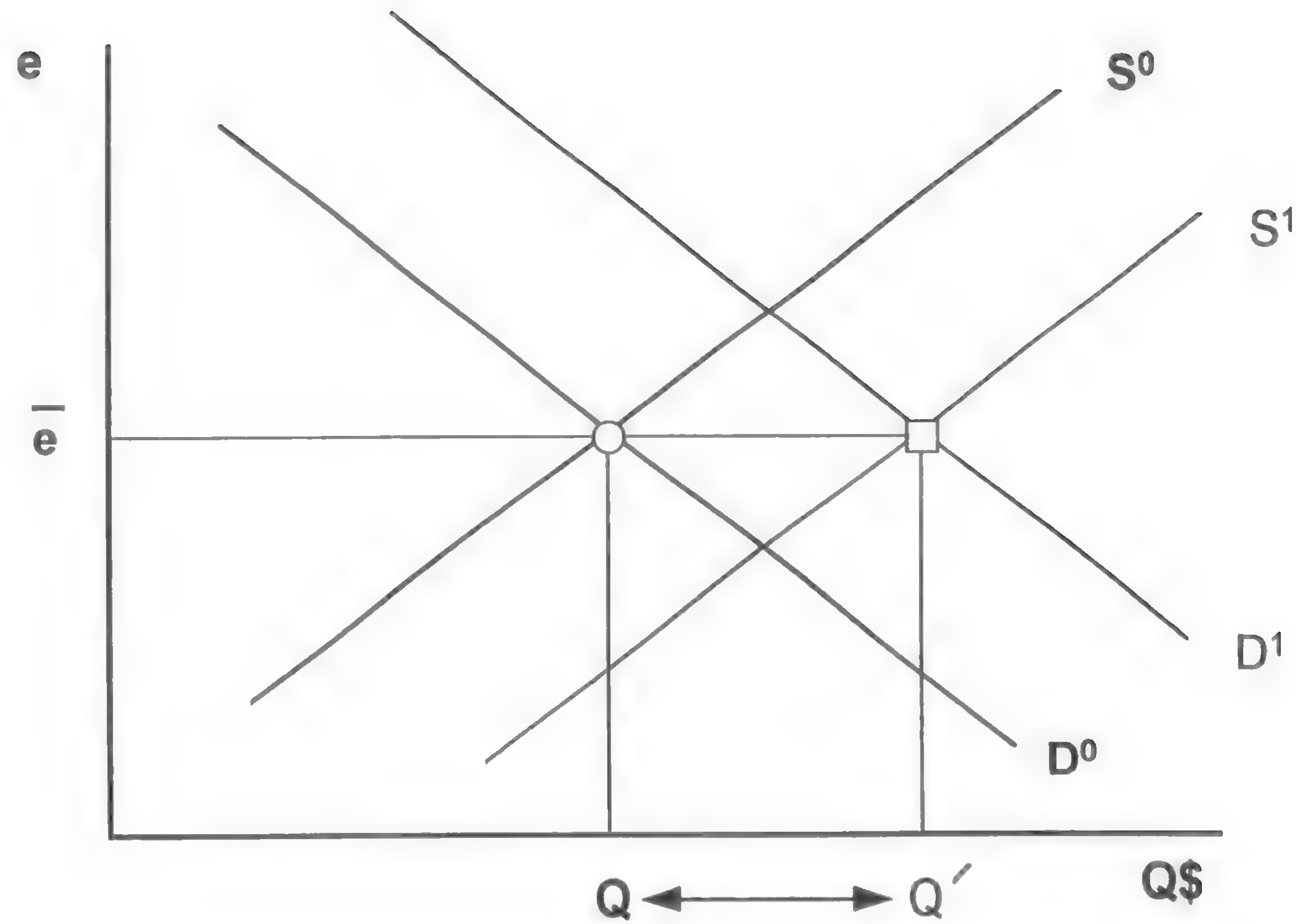


Figure XII.4 Fixed Exchange Rate System

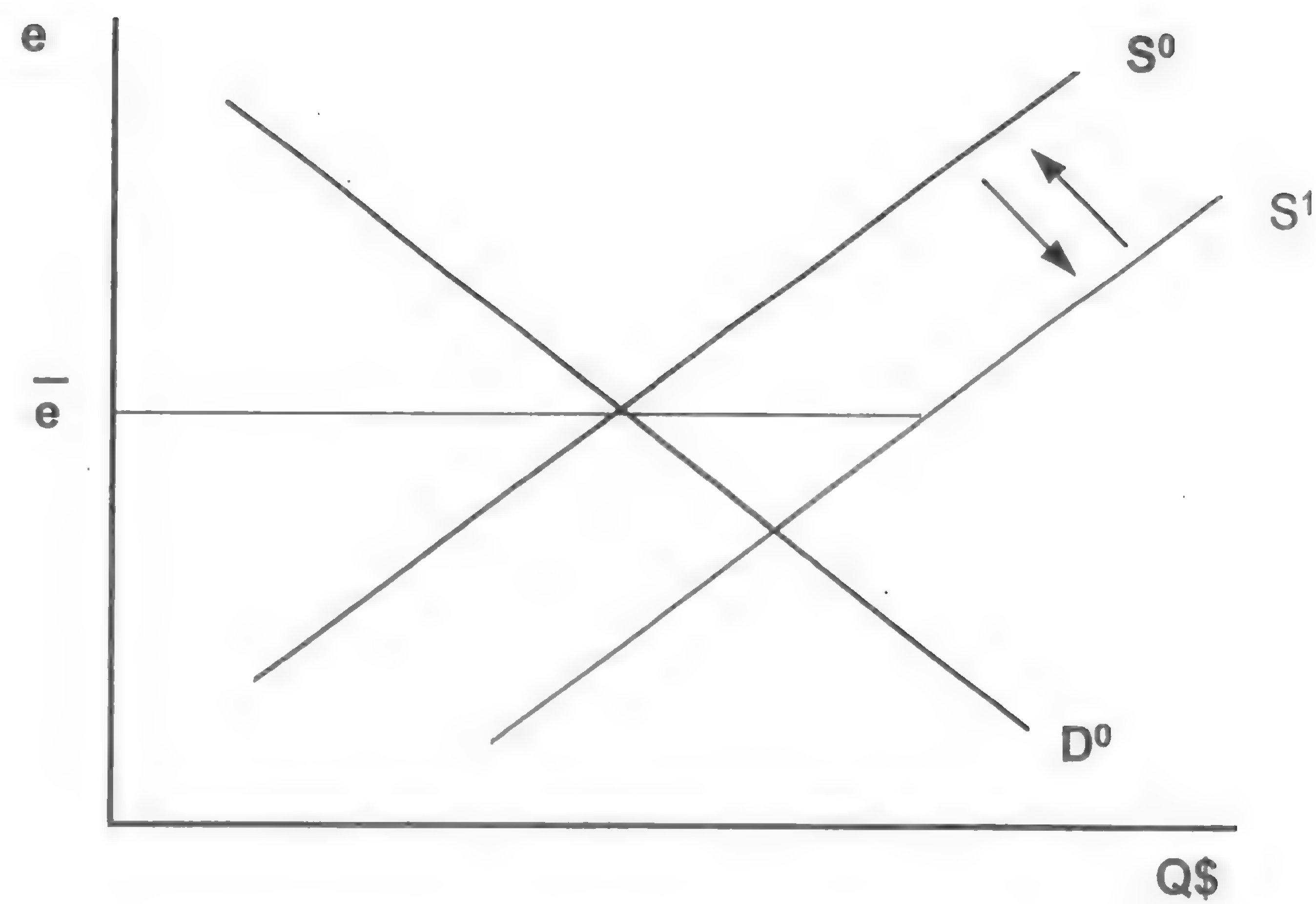


Figure XII.5 End of Fixed Exchange Rate System

the money supply can be offset by open market sales (purchases) of equal size.

A.5. Absence of Arbitrage Conditions

A.5.a. Definition If there are no trade barriers or transportation costs, arbitrage in goods and services implies that the foreign currency price of a bundle of goods in the U.S. ($e_t P_t$) should equal the foreign currency price of an identical bundle in the foreign country (P_t^f). This equality is known as Purchasing Power Parity (PPP). That is,

$$e_t \bullet P_t \equiv \frac{\#\text{foreign currency units}}{1\$} \bullet \frac{\#\$}{1 \text{ U.S. bundle}} = \frac{\#\text{foreign currency units}}{1 \text{ foreign bundle}} \equiv P_t^f$$

If $e_t P_t > P_t^f$, it is cheaper to buy goods in the foreign country. As U.S. citizens supply dollars in exchange for the foreign currency in order to purchase the goods in the foreign country, the dollar depreciates (i.e. e_t decreases until the equality is restored - see Figure XII.6a). On the other hand, if $e_t P_t < P_t^f$ it is cheaper to buy goods in the U.S. As foreign citizens demand dollars to purchase U.S. goods, the dollar appreciates (i.e. e_t increases until the equality restored - see Figure XII.6b).

The evidence for PPP is quite slim. One way we can see this is in Figures XII.7a to XII.7c, where $e_t P_t$ is graphed against P_t^f. If PPP held, the two lines should be equal.[11] For both Japan and Germany, the foreign currency price of purchasing U.S. goods ($e_t P_t$) exceeds the foreign currency price of purchasing foreign goods (P_t^f). This provides a good reason for the trade deficits we witnessed in Figure XII.1 (i.e. our goods were overpriced). In the case of the U.K., the two lines cross frequently, making foreign goods more expensive at times and U.S. goods more expensive at other times. These correspond to the trade surpluses and

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[11]We can test this arbitrage condition using linear regression techniques, with one simple transformation.

Math Fact: The logarithm of the product of 2 variables is simply the sum of the 2 products.

Using the math fact, we can write the nonlinear PPP relation as:

$$\log_e (e_t . P_t) = \log_e (P_t^f) \quad \text{or} \quad \epsilon_t = p_t^f - p_t$$

where $\epsilon_t \equiv \log_e(e_t)$, $p_t^f \equiv \log_e(P_t^f)$, $p_t \equiv \log_e(P_t)$. So if PPP held, in a regression of ϵ_t on p_t^f and p_t, the coefficient on p_t^f should be 1 and the coefficient on p_t should be -1.

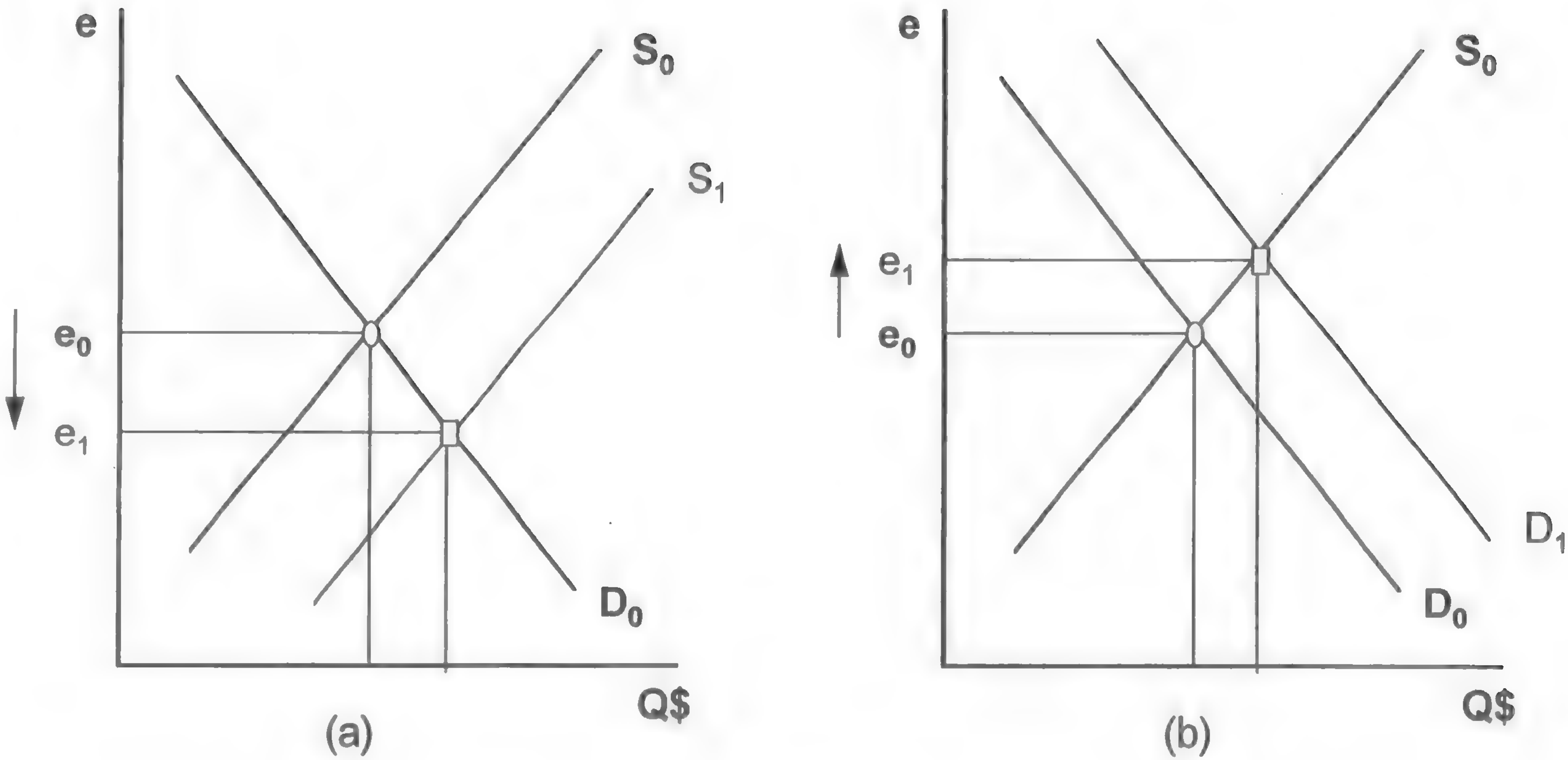

Figure XII.6 Purchasing Power Parity

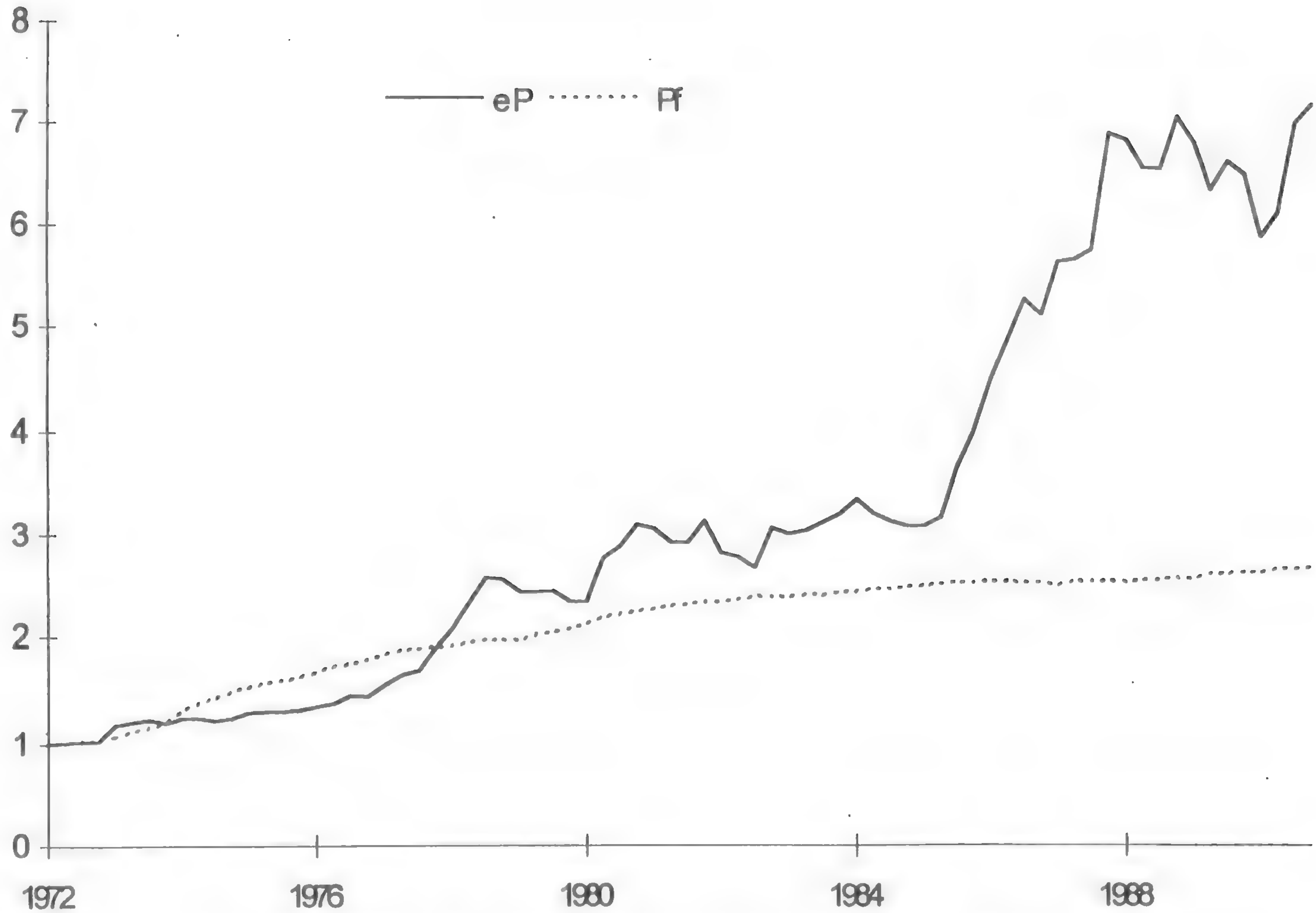

Figure XII.7a Purchasing Power (Japan vs US)

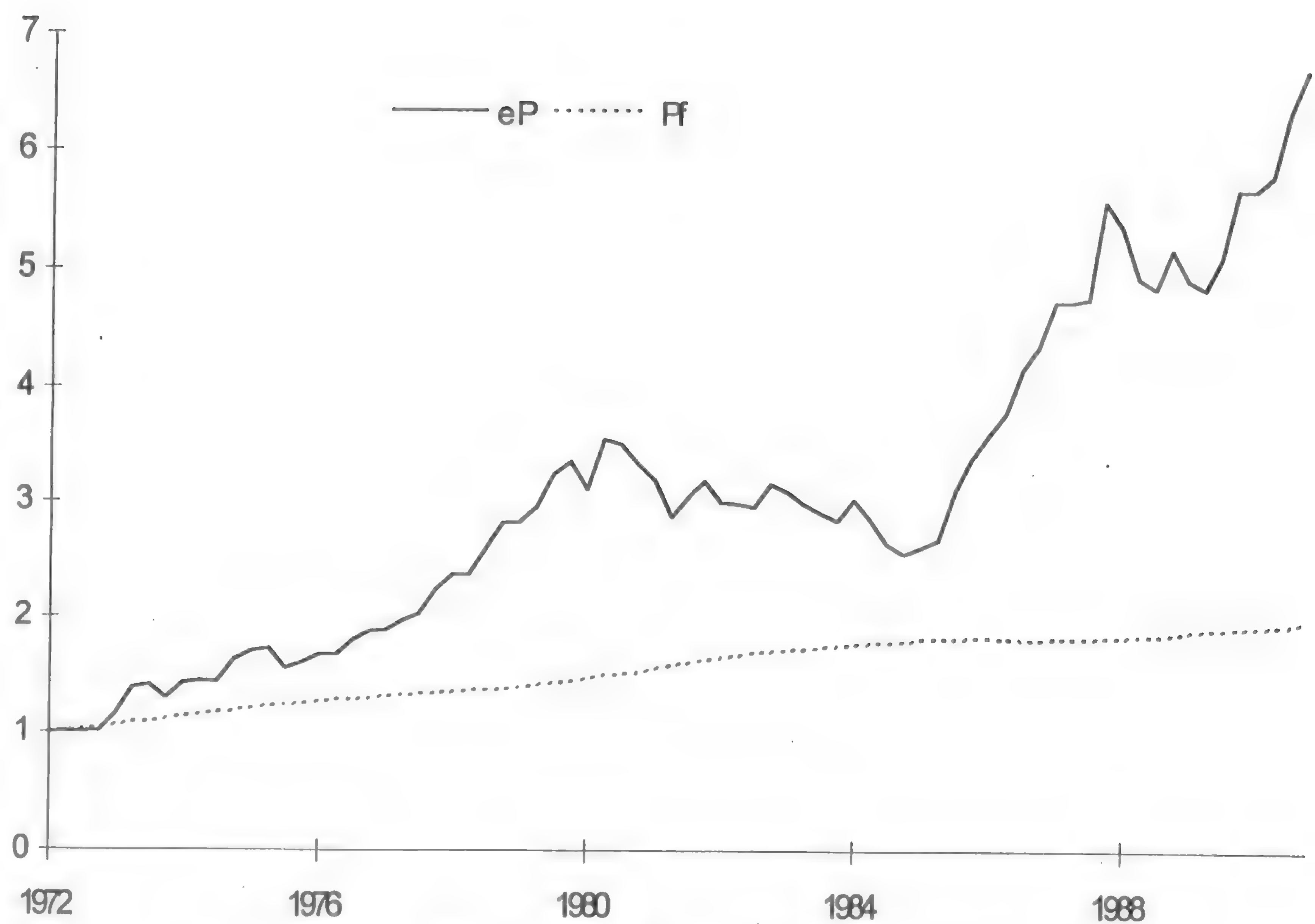

Figure XII.7b Purchasing Power (Germany vs US)

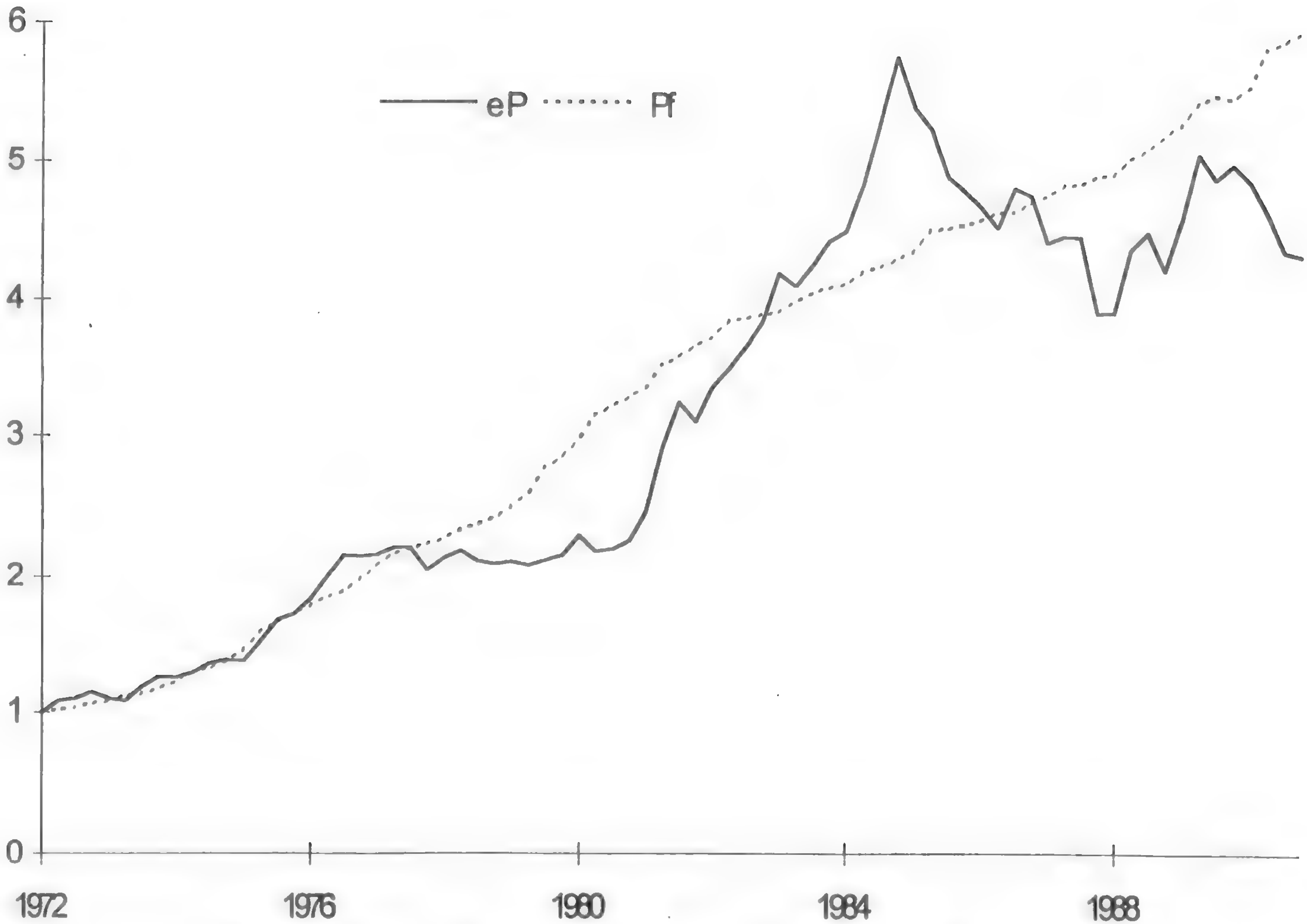

Figure XII.7c Purchasing Power (UK vs US)

deficits we ran with the U.K. in Figure XII.1.

A.5.b. Definition If there are no credit controls or transactions costs and speculators are risk neutral, bond market arbitrage implies the dollar return on U.S. bonds $(1+R_t)$ should equal the expected dollar return on foreign bonds $E\left[\frac{e_t(1+R_t^f)}{e_{t+1}} \mid \Im_t\right]$. This equality is known as *Uncovered Interest Rate Parity* (UIP).

Where does the equality come from? In Figure XII.8, we consider two options for a risk neutral speculator: either she can buy U.S. bonds or foreign bonds. If she doesn't care about risk, then the returns better be equalized on average. Why?

If $1+R_t > E\left[\frac{e_t(1+R_t^f)}{e_{t+1}} \mid \Im_t\right]$, then the speculator should buy U.S. bonds. To undertake this plan, speculators demand dollars (from D^0 to D^1 in Figure XII.9a) to purchase U.S. bonds. This leads to an appreciation of the dollar (i.e. e_t increases until the equality is restored).

If $1+R_t < E\left[\frac{e_t(1+R_t^f)}{e_{t+1}} \mid \Im_t\right]$, then the speculator should buy foreign bonds. To undertake this plan, speculators supply dollars (from S^0 to S^1 in Figure XII.9b) in exchange for foreign currency in order to purchase foreign bonds. This leads to a depreciation of the dollar (i.e. e_t decreases until the equality is restored). .

We can simplify this equality with a couple of transformations.

Math Fact: The logarithm of $1+x$, where x is a small number, is approximately x. See Figure XII.10.

Math Fact: The logarithm of $\frac{x_{t+1}}{x_t}$ is approximately the growth rate of that variable.

Why? Rewrite $\frac{x_{t+1}}{x_t}$ as $1+\frac{x_{t+1}}{x_t}-1$ or $1+\frac{x_{t+1}-x_t}{x_t}$ or 1+ growth rate of x. But then by

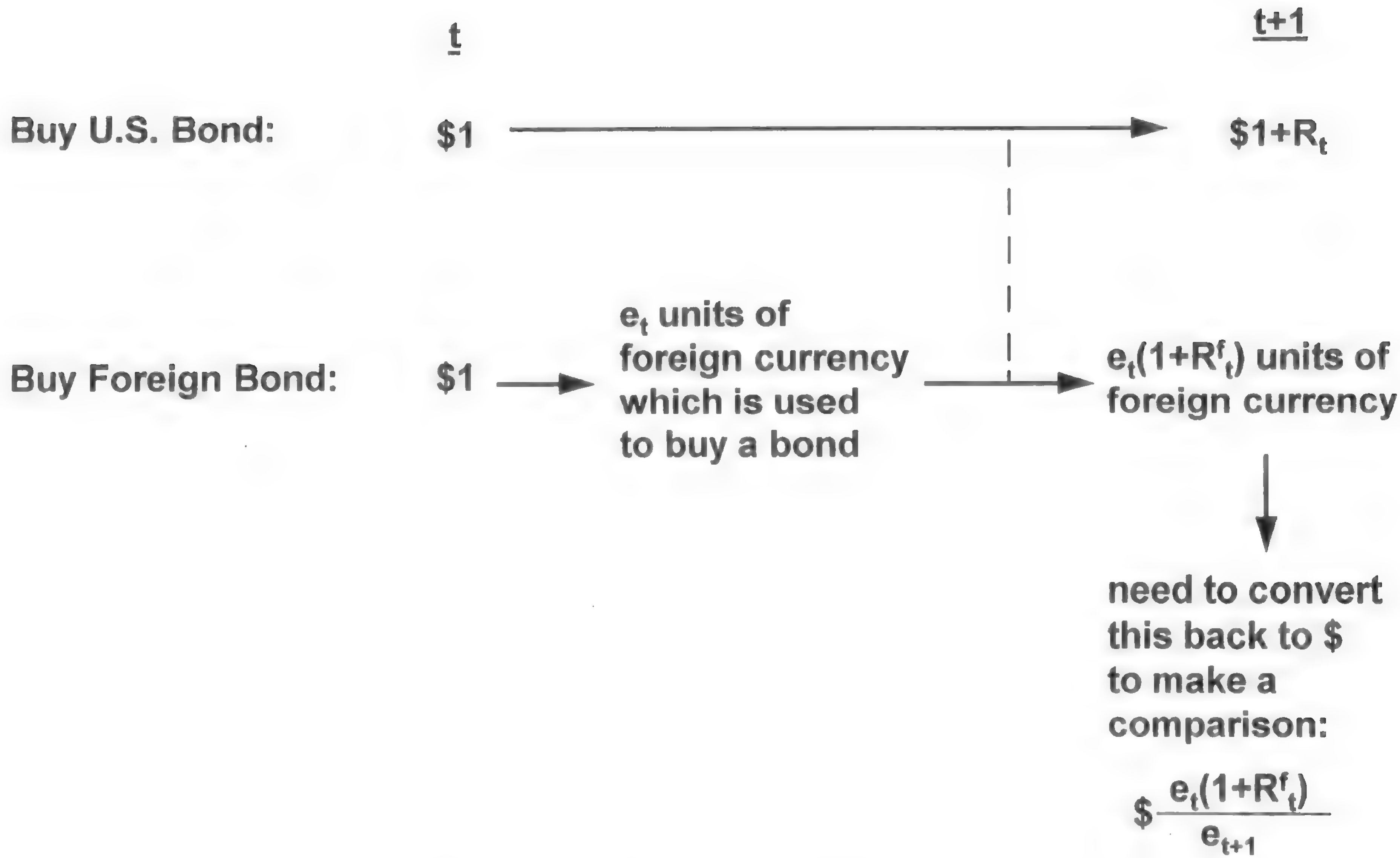

Figure XII.8 Uncovered Interest Rate Parity

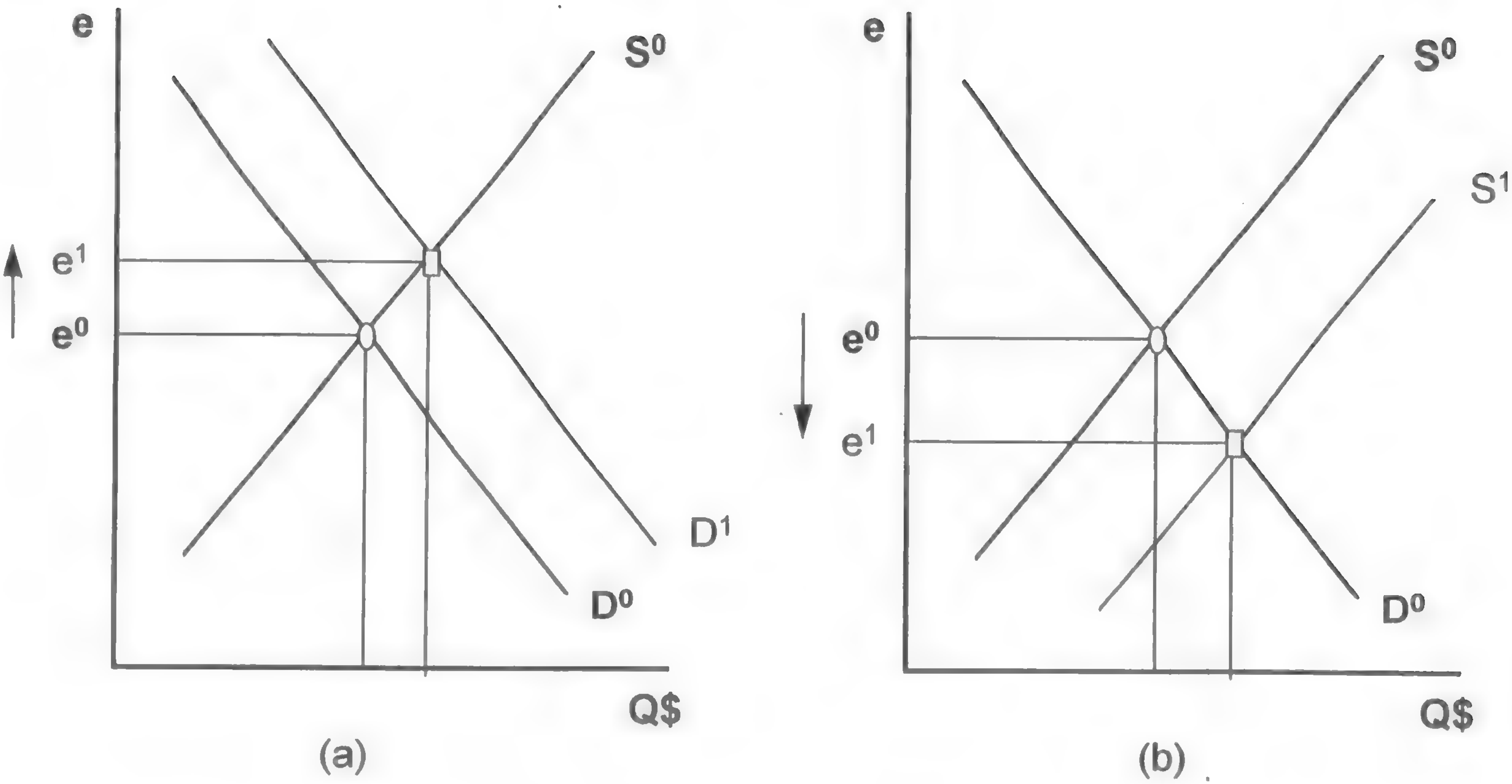

Figure XII.9 Uncovered Interest Parity

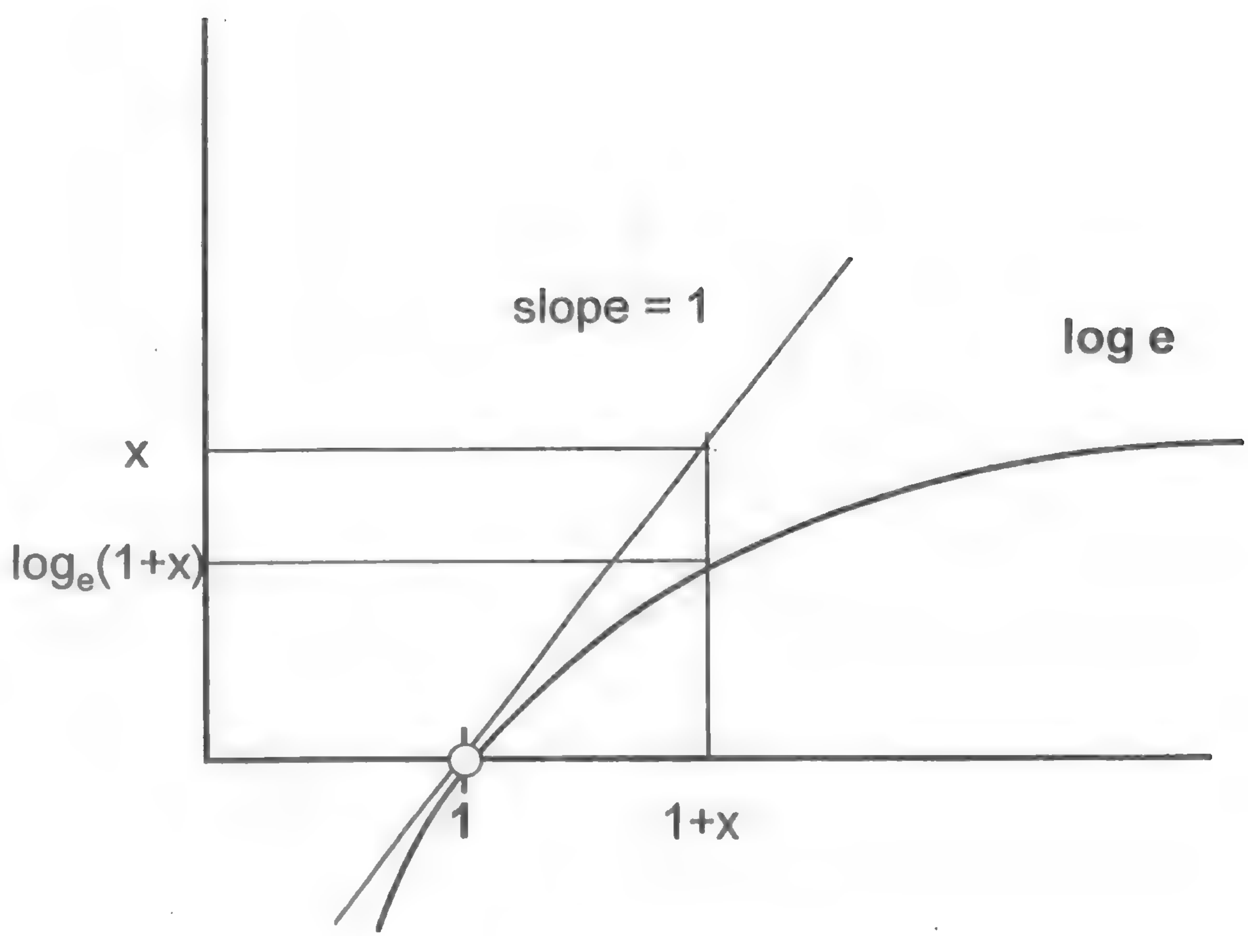

Figure XII.10 Logarithm of x

the previous math fact

$$\log_e \left[\frac{X_{t+1}}{X_t}\right] = \log_e \left(1 + \text{growth rate}\right) \approx \text{growth rate}$$

Using the previous 2 math facts, we can write the UIP condition as (approximately)

$$\log_e (1+R_t) = \log_e (1+R_t^f) - \log\left[\frac{e_{t+1}}{e_t}\right]$$

or

$$R_t + \text{expected dollar appreciation} = R_t^f$$

That is, absence of arbitrage requires that the foreign currency return on dollar denominated assets (which is just the dollar return on our assets plus any gains to appreciation of the dollar) must equal the return on foreign currency denominated assets. In Figures XII.11a to XII.11c we plot R_t + actual dollar appreciation (called "foreign speculation" in the graph) against R_t^f. If UIP held, the two lines should lie on top of each other.[12] As can be seen in Figures XII.11, it's pretty easy to reject UIP. One problem is the assumption that speculators are risk neutral; in this case, the above formula neglects important "risk premia" that can be uncovered from our asset pricing formulas. For instance, the covariance between growth in real output and appreciation of exchange rates that is part of the risk premium drives a wedge into

$$R_t + \%\text{ change in } e_t = R_t^f + \text{risk premium}_t$$

One way to get around the risk involved with future exchange rate movements in the above bond market arbitrage conditions is to cover your position in the forward market. That is, write a contract to buy or sell future currency at a price determined today (that is, at

[12] If UIP held, in a regression of the growth rate of the exchange rate on R_t and R_t^f, the coefficient on R_t^f should be 1 and the coefficient on R_t should be -1.

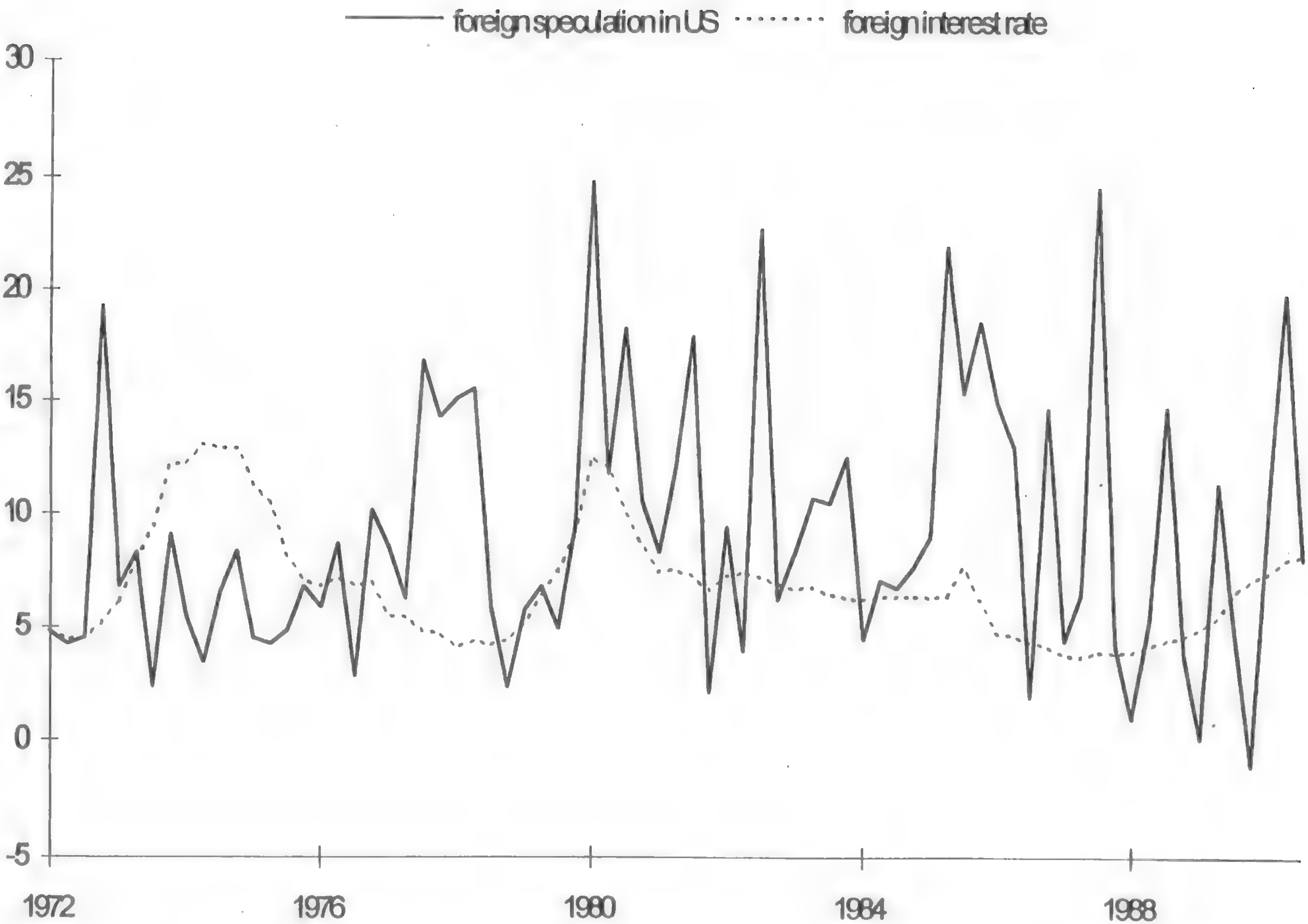

Figure XII.11a Uncovered Interest Parity (Japan vs US)

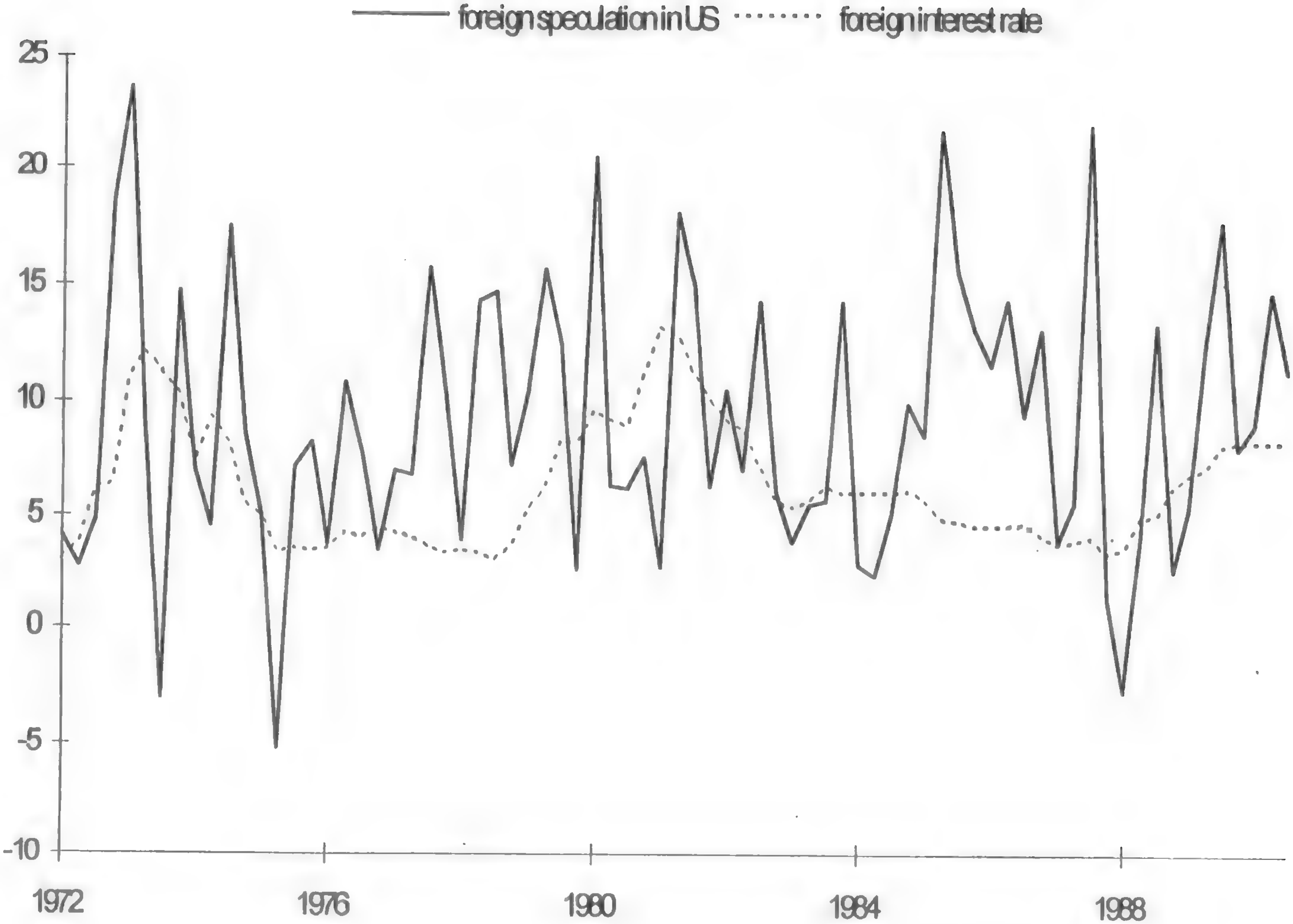

Figure XII.11b Uncovered Interest Parity (Germany vs US)

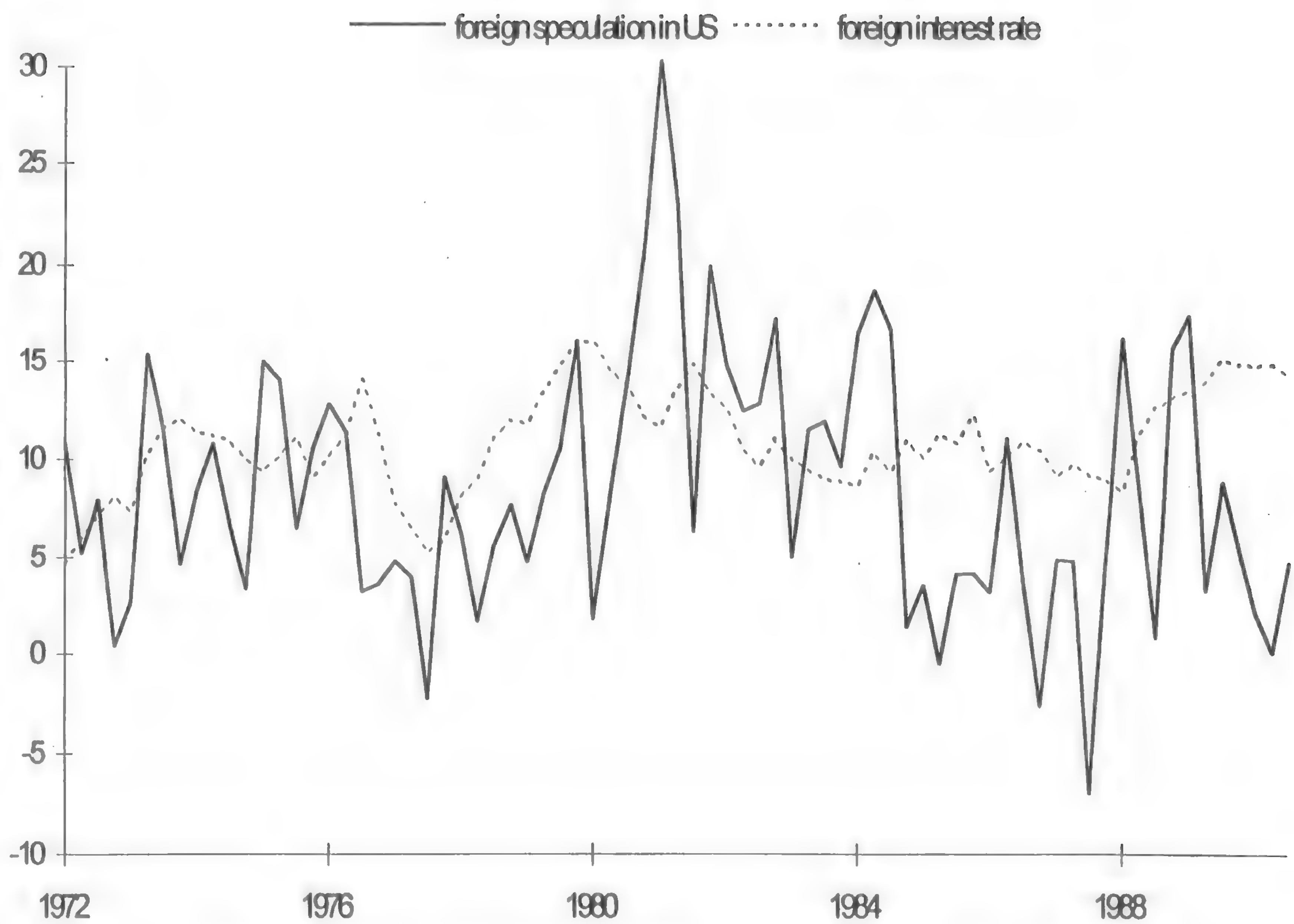

Figure XII.11c Uncovered Interest Parity (UK vs US)

a currently known price f_t^1, where $f_t^1 \equiv \dfrac{\#\text{ foreign currency at } t+1}{1\$}$.

Definition With perfect asset markets, bond market arbitrage implies the dollar return on U.S. bonds should equal the covered return on foreign bonds. That is,

$(1+R_t) = \dfrac{e_t(1+R_t^f)}{f_t^1}$. This equality is known as *covered interest parity* (CIP).

Notice that there is no variable unknown at time t in the above equality. That's why it is riskless.

A.5.c. Definition With perfect asset markets and risk neutral speculators, the forward rate should equal the expected future spot exchange rate. That is, $f_t^1 = E[e_{t+1} \mid I_t]$. This equality is known as the *unbiased forward rate hypothesis*.

For example, suppose $f_t^1 < E\,[e_{t+1} | I_t]$. Then buy dollars in the forward market (at a low price) and sell dollars in the spot market at t+1 (at a high price). If speculators keep buying dollars in the forward market, this excess demand will increase f_t^1 until equality is restored (see Figure XII.12a). Similarly, if $f_t^1 > E[e_{t+1} | I_t]$, a speculator should sell dollars in the forward market (sell high) and buy dollars in the spot market at t+1 (buy low). See Figure XII.12b.

In Figures XII.13a to XII.13c we plot f_t^1 against actual one period ahead exchange rates e_{t+1}. If the unbiased forward rate hypothesis holds, the two lines should lie on top of each other.[13] As can be seen by the figures, forward rates are a good predictor of the actual future spot exchange rate.

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[13]We can test this arbitrage condition using linear regression techniques. In a regression of the spot exchange rate on the lagged forward rate, the coefficient on f_t^1 should be 1. Furthermore, the forecast errors in predicting S_{t+1} (just the residuals of this regression) should not be predictable themselves (or else we could use past errors to help predict future errors).

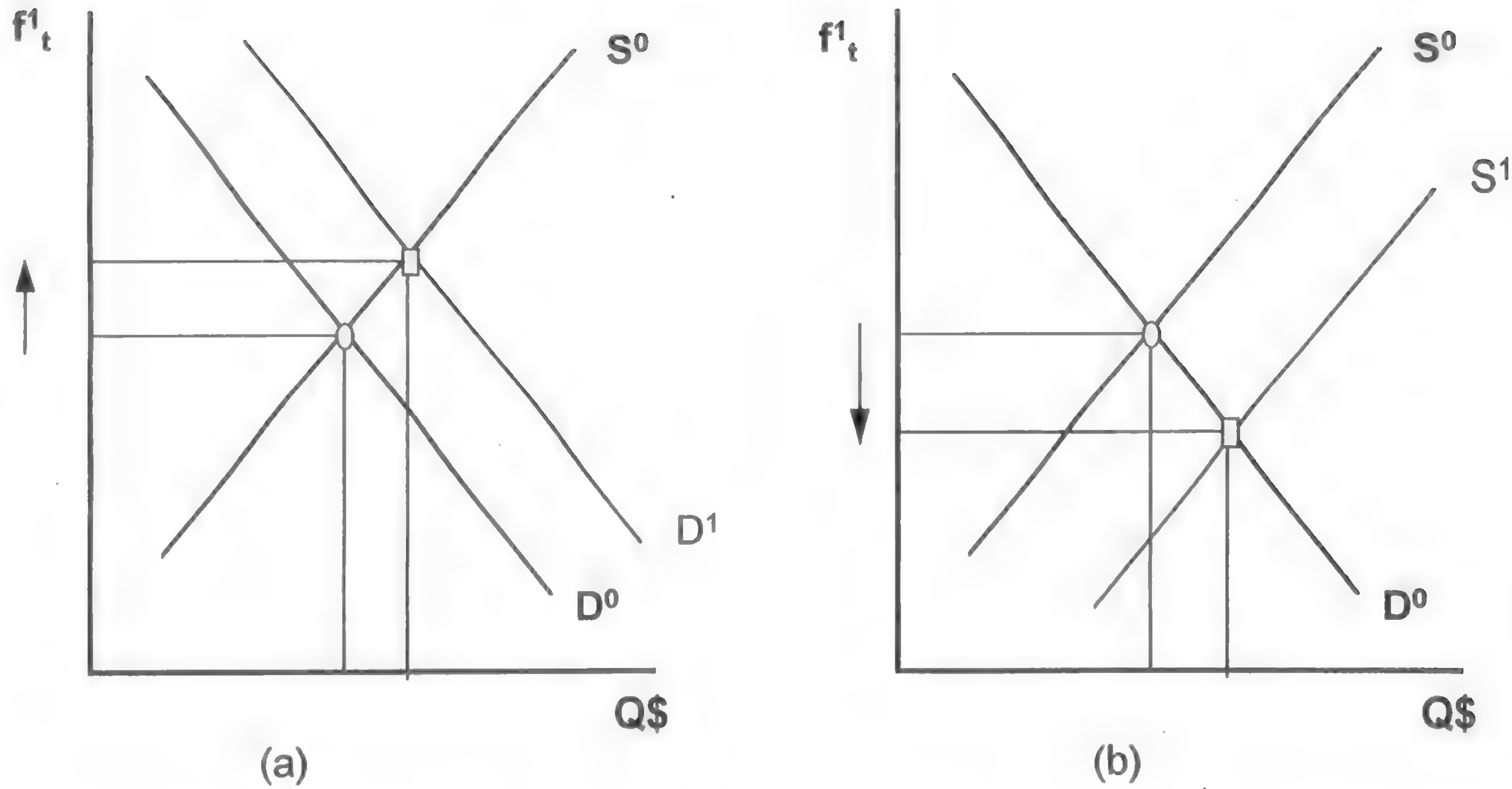


Figure XII.12 Unbiased Forward Rate Hypothesis

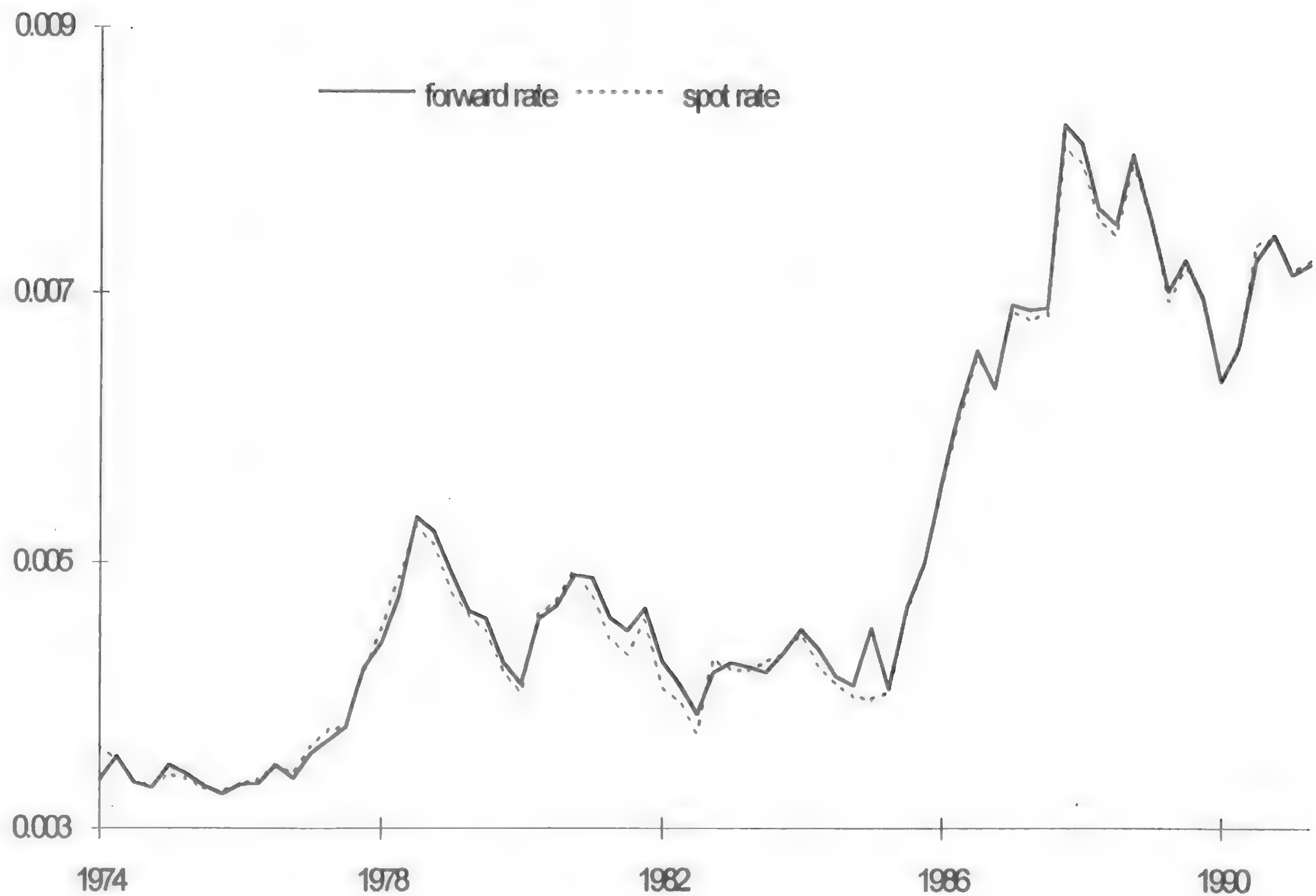


Figure XII.13a Forward and Spot Exchange Rate (Japan vs US)

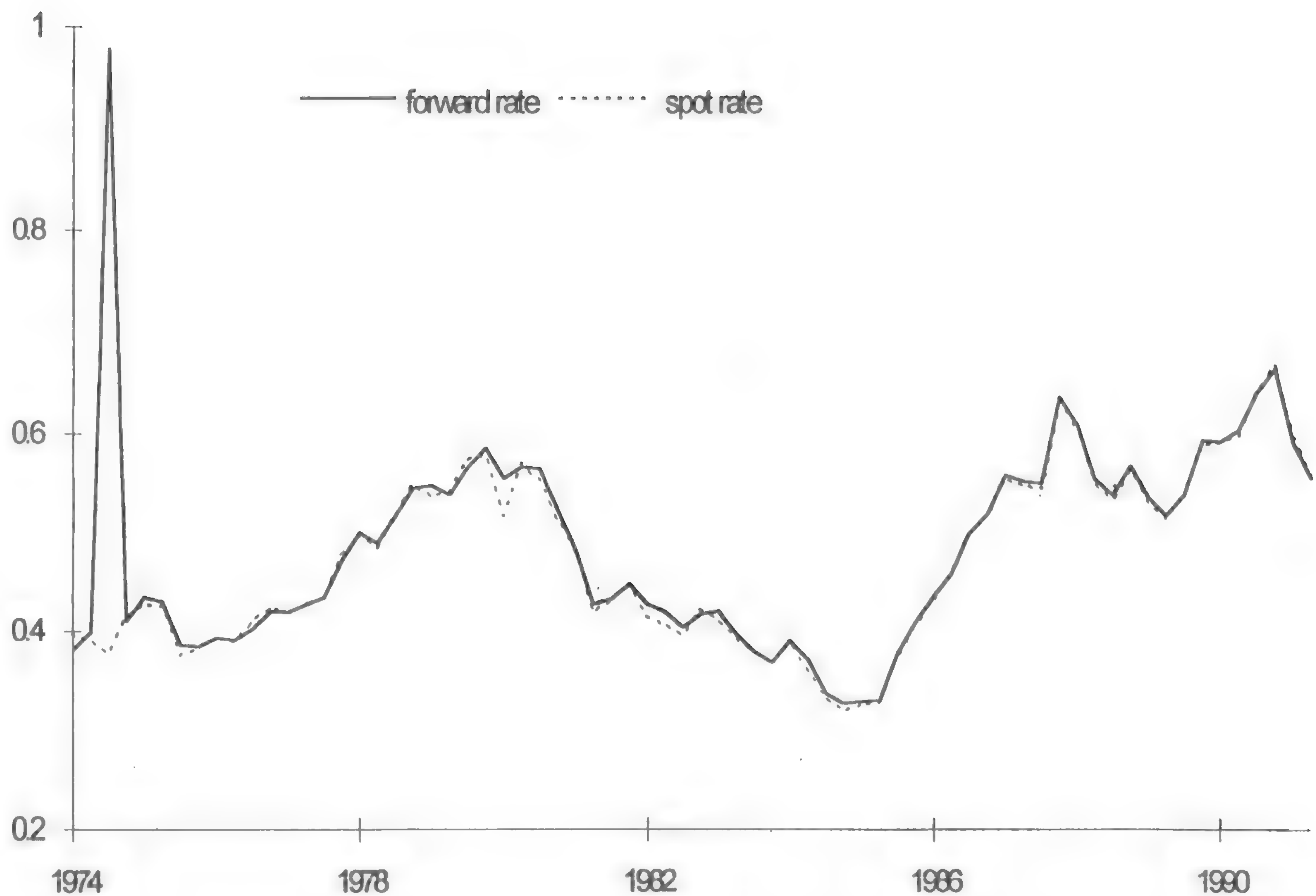


Figure XII.13b Forward and Spot Exchange Rate (Germany vs US)

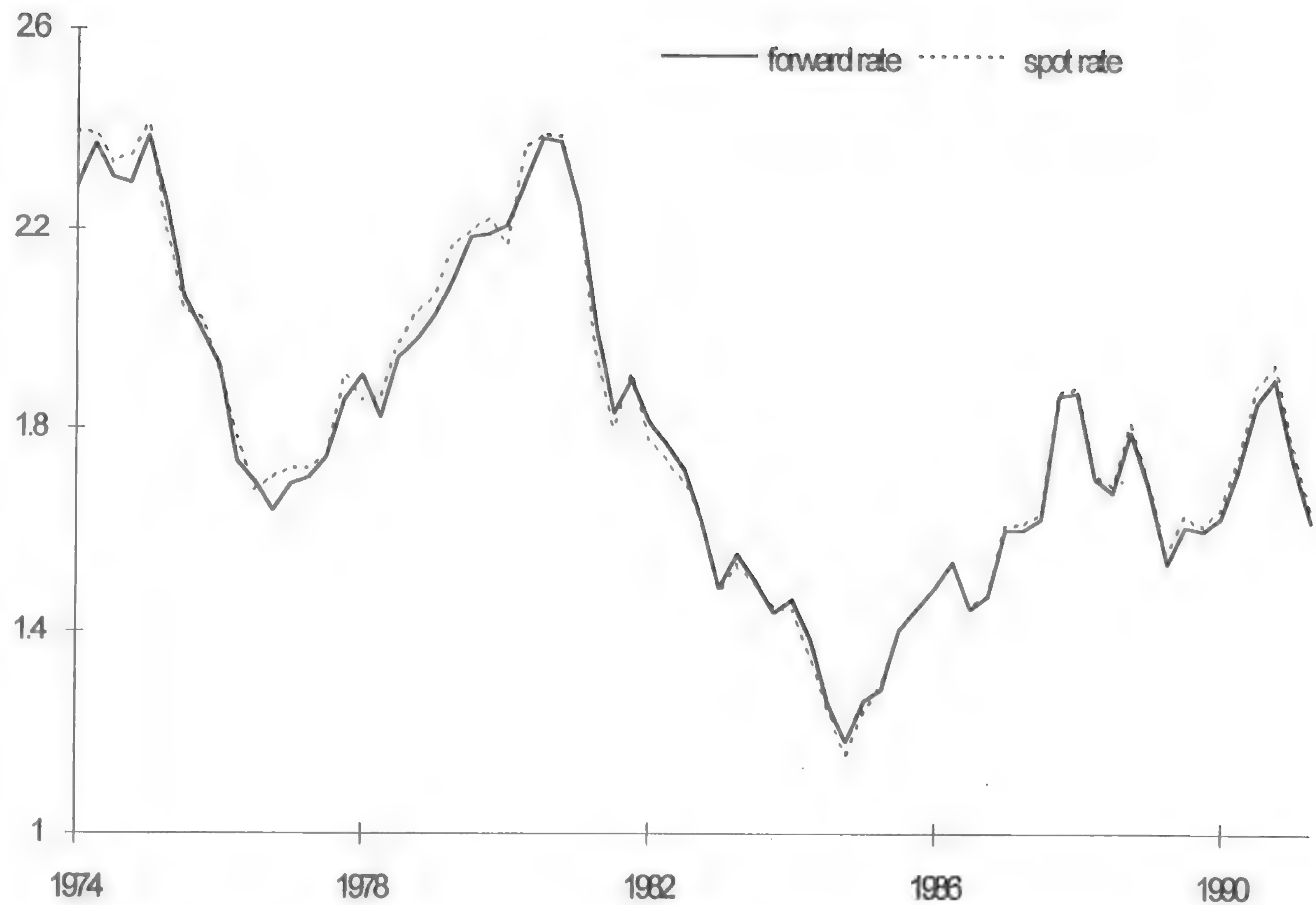


Figure XII.13c Forward and Spot Exchange Rate (UK vs US)

A.5. Definition With perfect markets and risk neutral speculators, UIP and the % change form of PPP imply the equality of expected real interest rates across countries. This equality is known as *real interest rate parity*. That is,

$$\text{UIP} \rightarrow E[\%\text{ change in } e_t] = R_t^f - R_t$$

$$\%\text{ change form of PPP} \rightarrow E\,[\%\text{ change } e_t] = E[\pi_t^f - \pi_t | I_t]$$

which implies (equating the left hand sides of the above two equations)

$$R_t - E[\pi_t | I_t] = R_t^f - E\,[\pi_t^f\,| I_t]$$

Figure XII.14 plots real interest rates between the U.S., Japan, Germany, and U.K. If real interest rate parity held, the lines should lie on top of each other. Notice that they do follow in a band of one another, providing some support for equalization of real interest rates across countries.

B. THE ROLE OF INTERNATIONAL CREDIT MARKETS AND THE SMOOTHING OF SHOCKS

For individuals, the bond market allowed for a divergence between expenditures and receipts. That is, if the individual had a temporary decrease in income, she could borrow or dissave. In a closed economy with no capital or government, there was no way for the economy as a whole to save or dissave. That is, in the goods market we had

$$S^{priv} \equiv Y_t - C_t = 0$$

In that case, when the economy as a whole tries to borrow, it cannot. Instead, the real interest rate adjusts so that demand equals to supply.

When we added capital, there was another source for dissaving. That is, the economy can run down the capital stock. In the goods market we had

$$S^{priv} \equiv Y_t - C_t = I_t$$

Adding government also allowed another source since we can rewrite the goods market clearing condition

$$Y_t = C_t + I_t + G_t$$

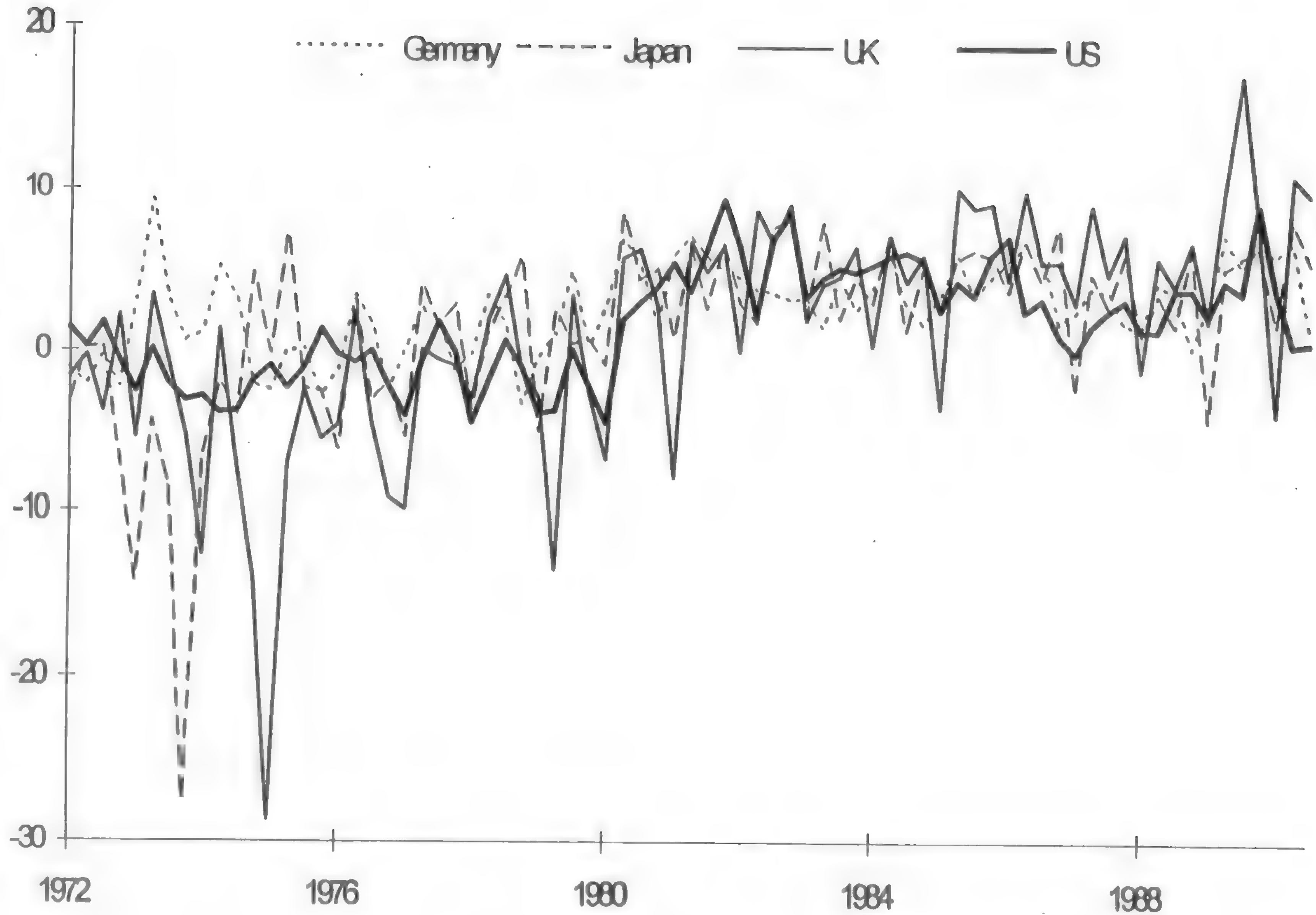


Figure XII.14 Real Interest Rates

as

$$S^{priv} \equiv Y_t - C_t - T_t = I_t - (T_t - G_t) \equiv I_t - S^{govt}$$

In that case, if the government dissaves (i.e. runs a budget deficit where $S^{govt} < 0$), either private citizens have to save more (as predicted by the Ricardian theory) or private investment gets crowded out.

Now, when we add the rest of the world, the goods market clearing condition

$$Y_t + \frac{R_{t-1}B^f_{t-1}}{e_t P_t} = C_t + I_t + G_t + Ex_t + \frac{R_{t-1}B^f_{t-1}}{e_t P_t} - \frac{P^f_t Im_t}{e_t P_t}$$

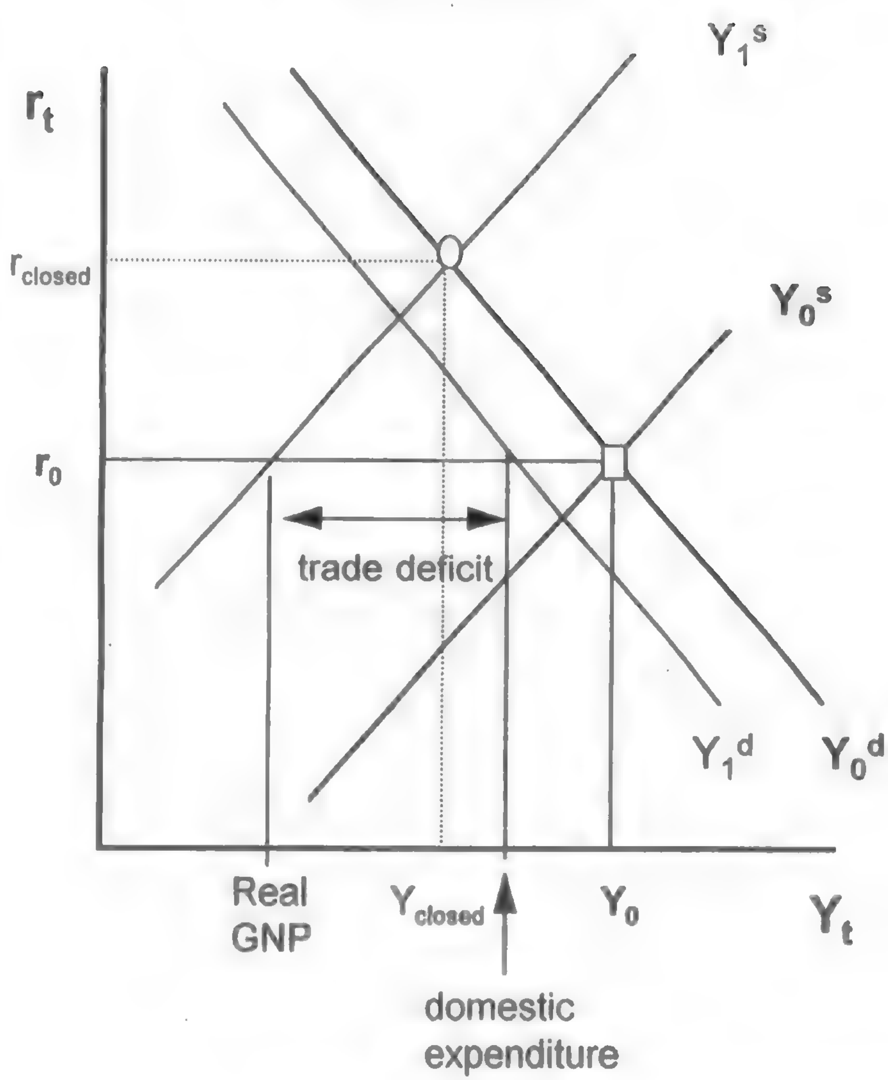
which can be written as

$$S^{priv}_t = I_t - S^{govt}_t - S^f_t$$

where $S^f_t \equiv$ net foreign savings in the U.S. i.e. just the flip side of the capital account. These modifications can be seen in the goods and bond market diagrams. The modification to the goods market diagram is that $C^d_t + I^d_t + G_t$ can be thought of as the domestic demand for U.S. goods while $Ex_t - P^f_t Im_t/(e_t P_t)$ can be thought of as net foreign demand. Any difference between $Y_t + R_{t-1}B^f_{t-1}$ and $C^d_t + I^d_t + G_t$ is simply due to the current account (trade in goods and services). The flip side of the current account is just trade in assets (the capital account). This modifies the bond market diagram. Now foreign net saving in the U.S. is added to the supply of funds in the U.S. (ie. $B^f_t - B^f_{t-1} < 0$) is added to the savings curve.

Example 1. Consider a temporary negative productivity shock. An important question in the international context is whether this shock is country specific. For instance, we have concentrated on oil price shocks as an example of a temporary negative productivity shock. The oil price shock was to a large extent felt by a lot of nations. In this case, it is hard for the excess demand for goods that accompanied the oil price shock of the earlier chapters to be accomodated by an inflow of savings from other countries because the other countries may be experiencing the same desire to borrow in order to smooth out the negative productivity shock. Needless to say, during the oil price shock of 1974, there was an inflow of savings from OPEC nations into the U.S.

To review the effects in the closed economy, see Figure XII.15. A decrease in θ_t causes the aggregate supply of goods produced in the U.S. to fall as the marginal benefit to producing



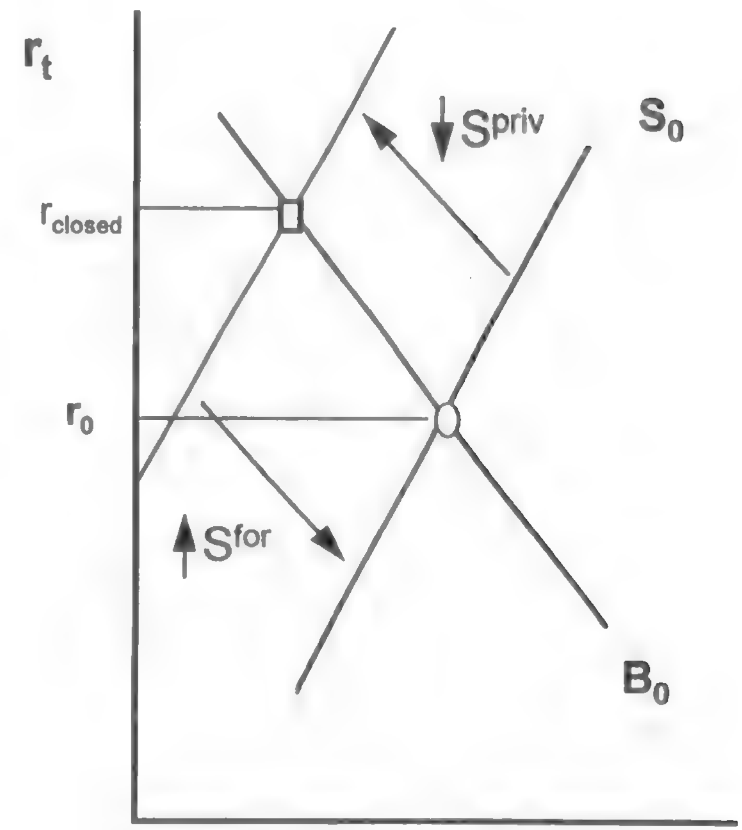


Figure XII.15 Open Economy Temporary Shock ($\theta_t \downarrow$

and working drops relative to the cost (i.e. Y^s shifts from Y^s_0 to Y^s_1). Consumption demand falls slightly as well, shifting Y^d from Y^d_0 to Y^d_1. Since the shock was assumed to be temporary (i.e. there's no change in expected θ_{t+1}), and capital takes time to put in place, there's no change in investment. The net effect in the closed economy goods market is for output to drop from Y_0 to Y_{closed} and interest rates to rise from r_0 to r_{closed}.

In an open economy, the above analysis is incomplete. At the old interest rate r_0, the demand for goods in the U.S. exceeds the supply of goods in the U.S. U.S. citizens would like to borrow to smooth consumption. That's why the interest rate rose to r_{closed}. But now, since $r_{closed} > r_0$, the U.S. is an attractive place for foreigners to save. In this case, foreign savings flow into the U.S. (see the bond market diagram). The inflow of savings will continue until r_{closed} returns to r_0. The difference between Y_{closed} and $C^d_1+I^d+G$ is resulting trade deficit (i.e. inflow of goods that is the flipside of our outflow of IOUs).

In this case, while domestic production in the U.S. falls, the trade balance worsens as well. This would imply procyclicality of the current account. If the shock was persistant, (i.e. θ_t and θ_{t+1} both fall), investment demand would shift back. In that case, domestic production may actually outweigh domestic expenditure, and the U.S. would run a current account surplus. This would imply countercyclical current accounts. See Figure XII.16. In Figure XII.17, we present deviations from trend of real GNP and the real current account. The correlation in the data is weakly countercyclical at -.21.

Of course, the above analysis has to be tempered by the fact that if all countries are experiencing a similar decrease in θ_t, there will be less savings flowing just to the U.S.; another reason for the weak correlation.

Example 2. Here we consider temporary changes in government expenditure (this analysis follows the Table in Chapter 2 on page 6). Suppose the government runs a big government deficit (as in 1983 where it was 3.8% of GNP). Then if private saving and investment are relatively unchanged (s^{priv} fell slightly to 17.4% of GNP and I_t rose slightly to 14.7%), the deficit must be financed by foreign savings. This is witnessed by a fall in the current account from 0% of GNP in 1982 to -1% of GNP in 1983. But the current account is just another measure of foreign saving in the U.S. (i.e. when we run a deficit in goods trade, we have to pay them back in IOUs). The important point is that international lending allowed domestic spending to remain relatively constant despite a sizeable fiscal policy shock.

How do we see this graphically? Consider an increase in G_t financed by distant future income taxes (for simplicity we'll neglect the current effects on work effort, consumption, and investment). See Figure XII.18. The increase in government expenditures implies a decrease (shift) of S^{govt} (i.e. government must finance the deficit with borrowing) in the bond market. This puts upward pressure on U.S. real interest rates from r_0 to r_{closed}. Foreign

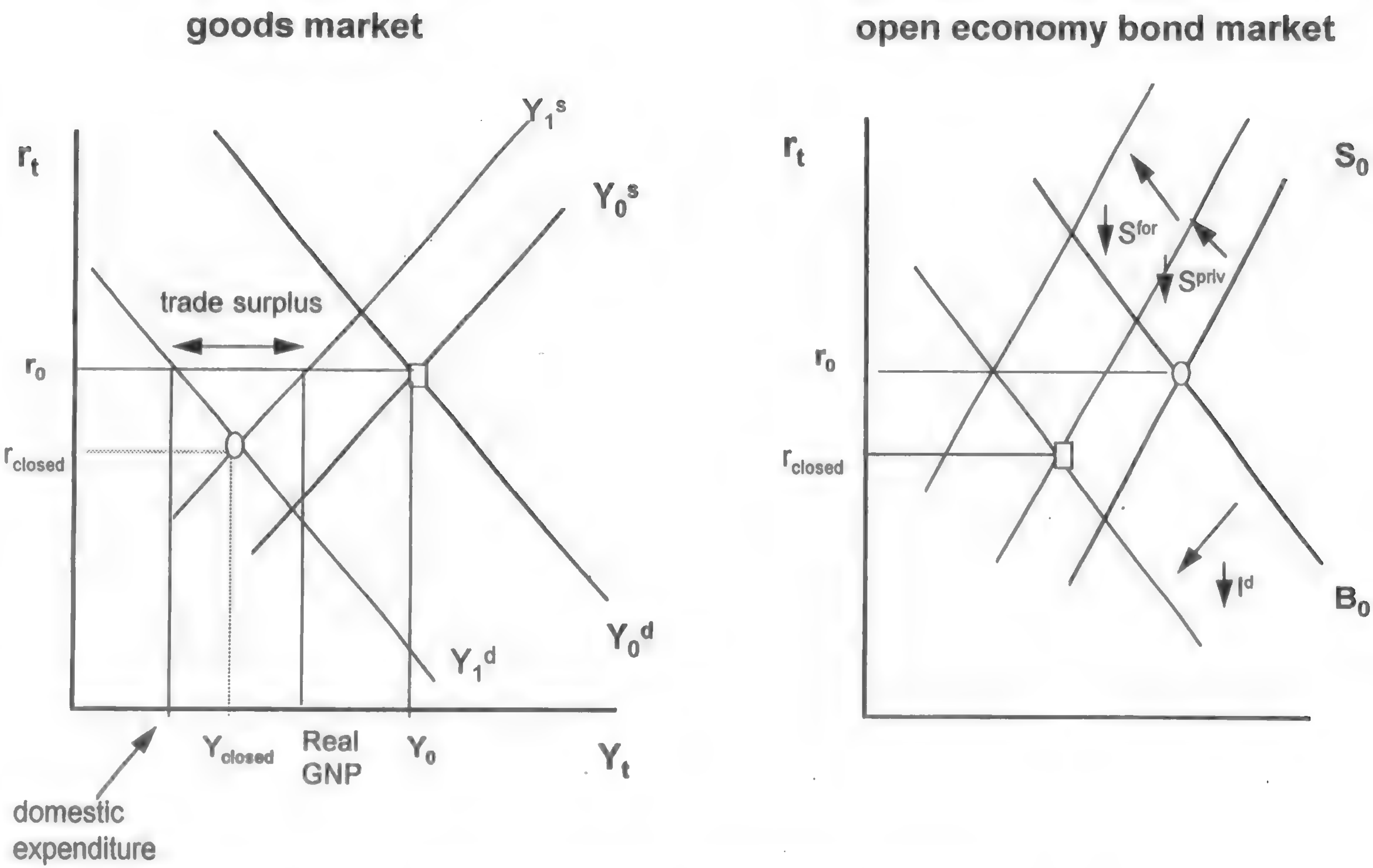


Figure XII.16 Open Economy Persistent Shock (θ_t , θ_{t+1} ↓)

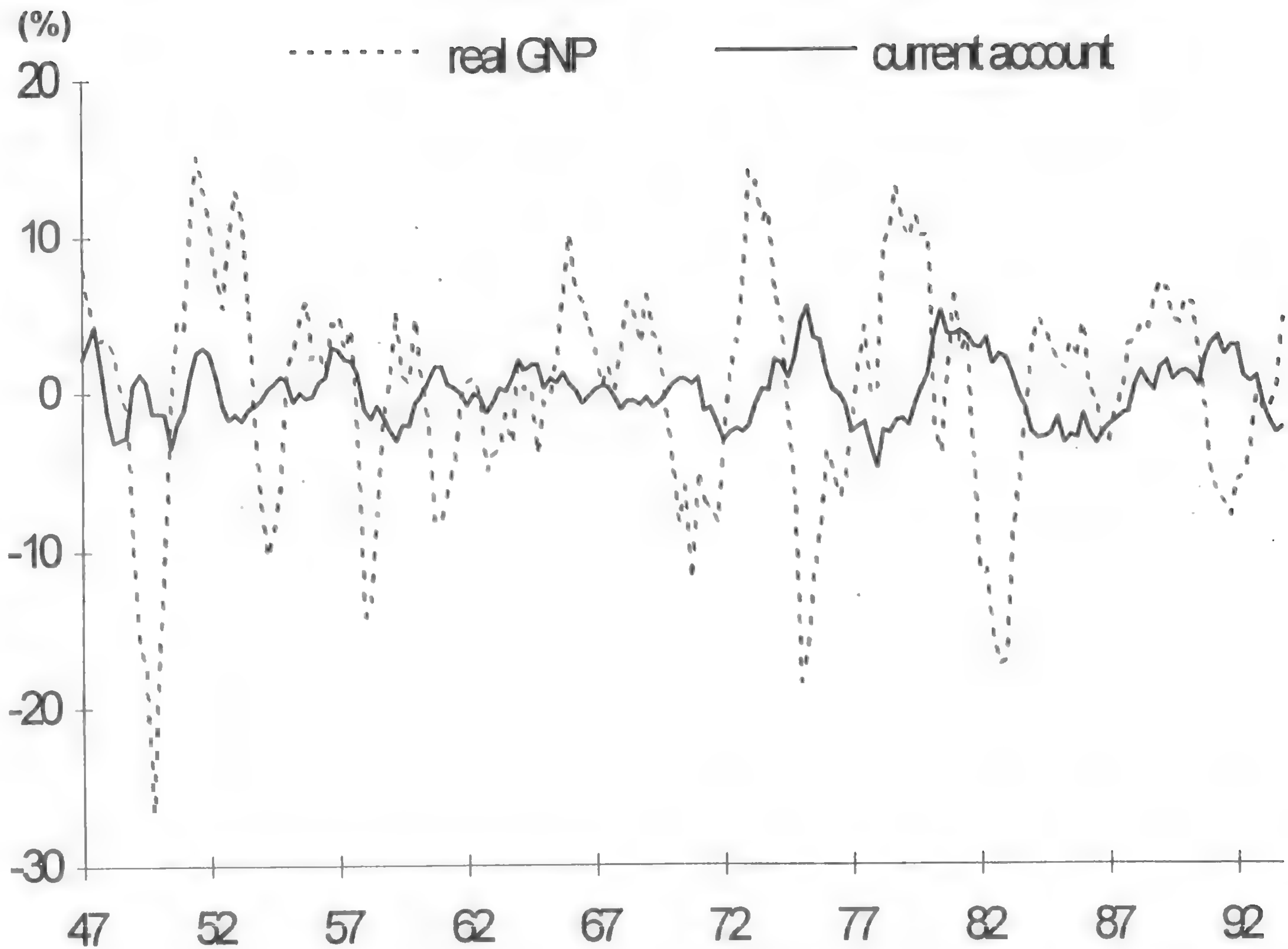


Figure XII.17 Deviations from Trend: Real GNP and Current Account/real GNP

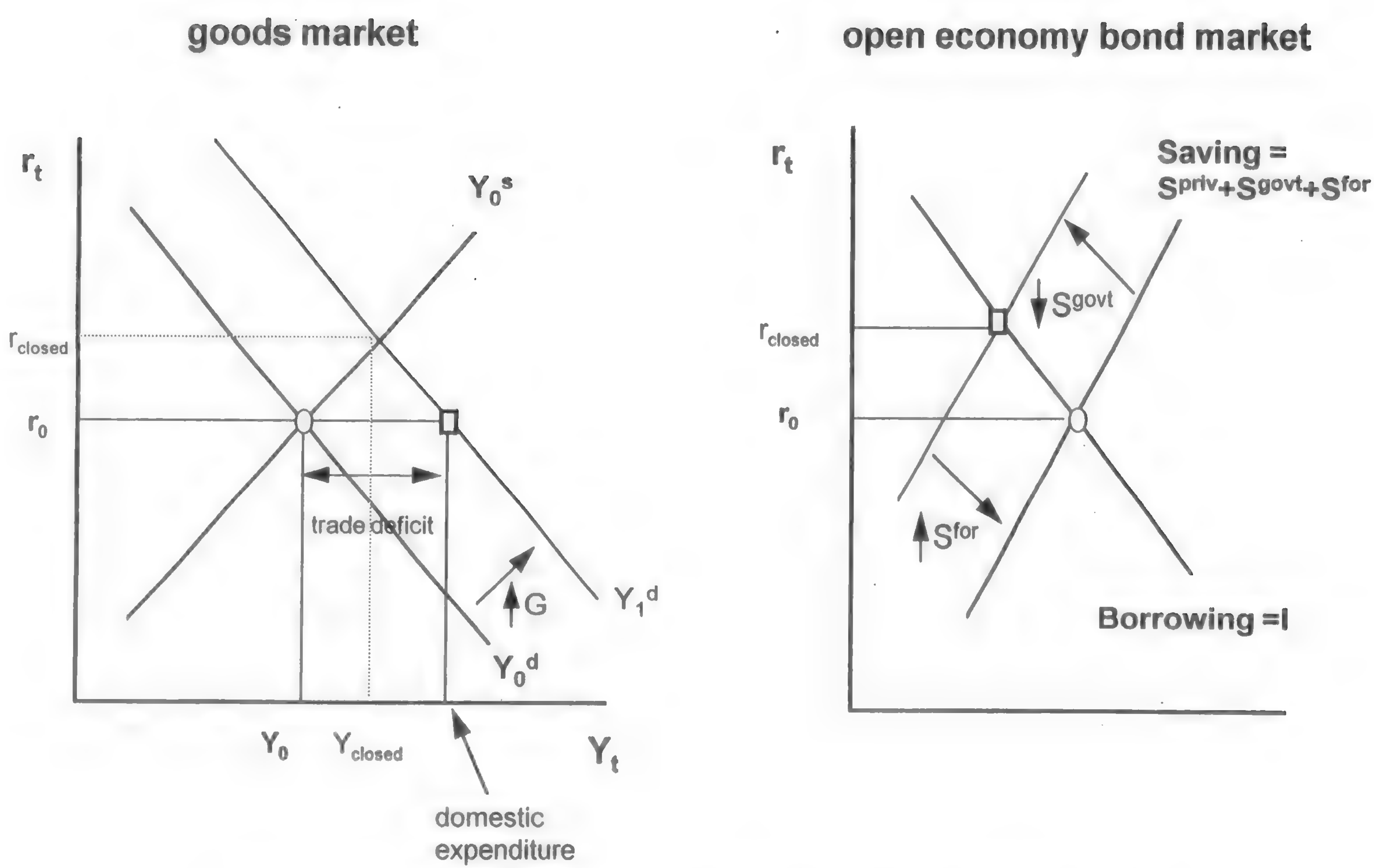


Figure XII.18 Open Economy Government Expenditure

residents would want to take advantage of the higher real returns in the U.S.; in this case they save more in the U.S. (increase in S^{for} shifts saving curve back to its original position in Figure XII.18). To pay for this excessive domestic U.S. expenditure, the U.S. runs a current account deficit.

C. SUMMARY

In open economy macroeconomics, we need to think about domestic conditions "relative" to the rest of the world. What is the relationship between domestic currency and foreign currency? We saw this is just given by the nominal exchange rate. What is the price of domestic goods relative to foreign goods? We saw this question underlies Purchasing Power Parity. What is the return on domestic assets relative to foreign assets? We saw this question underlies Uncovered Interest Rate Parity. What is the mix of expenditure on domestic goods relative to foreign goods? We saw this question underlies the determination of savings flows in response to real interest rate differentials.

To understand goods and savings flows across countries, we use the logic of assessing where the marginal benefit is greater than the marginal cost. For instance, goods will be purchased in the domestic country if the marginal benefit of purchasing at home exceeds the marginal cost; i.e., $e_t P_t < P_t^f$. Also, savings will flow into the domestic country when the marginal benefit of saving domestically exceeds the marginal opportunity cost; i.e.,

$$1+R_t > E\left[\frac{e_t(1+R_t^f)}{e_{t+1}} \mid \Im_t\right] \quad \text{or } R_t - E[\pi_t | I_t] > R_t^f - E[\pi_t^f | I_t].$$

Appendix

Index of Symbols

$t, t+1 \equiv$ period t and t+1, or the present and future.

$n_t^{js} \equiv$ labor hours supplied (in period t by household j).

$n_t^{jd} \equiv$ labor hours demanded (in period t by firm j).

$k_t^j \equiv$ real capital stock (in period t by firm j)

$y_t^j \equiv$ real output of the composite good generated by a production function.

$\theta_t f(n_t^j, k_{t-1}^j) \equiv$ the production function, where θ_t is the current state of technology.

$y_t^j / n_t^j \equiv$ labor productivity.

$\omega^{RS} \equiv$ reservation wage.

$c_t^j \equiv$ real consumption of a bundle of goods.

$r_t \equiv$ real interest rate, the relative price of future consumption goods in terms of current consumption goods.

$b_t^j \equiv$ real bond holdings, claims or obligations to $(1+r_t)b_t^j$ units of the consumption good at period t+1 in exchange for b_t^j units of the good supplied or received in period t.

$C_t^d \equiv$ aggregate consumption demand, which is just $\sum_{j=1}^{J} c_t^j$.

$K_t \equiv$ aggregate stock of capital, which is just $\sum_{j=1}^{J} k_t^j$.

$N_2 \equiv$ aggregate hours, which is just $\sum_{j=1}^{J} n_t^j$.

$I_t^d \equiv$ gross investment demand, which is just $K_t - K_{t-1} + dK_{t-1}$.

$\delta \equiv$ depreciation rate on capital.

$G_t \equiv$ real government expenditure.

$T_t \equiv$ real tax revenues, either raised through lump sum taxation or distortionary marginal tax rates τ_t.

$Y_t^s \equiv$ aggregate supply of goods, which is just $\sum_{j=1}^{J} y_t^j$.

$W_t \equiv$ nominal wage rate.

$P_t \equiv$ aggregate price level. Hence $P_t c_t^j$, $P_t y_t^j$, and $P_t b_t^j$ are nominal consumption expenditure, nominal output, and nominal bond holdings, respectively.

$\omega_t \equiv$ real wage rate.

$m_t^j \equiv$ nominal money holdings (end-of-period). Hence $m_t^j/P_t \equiv$ real money holdings.

$$\frac{\bar{m}_t^j}{P_t} \equiv \textit{average real money holdings over the period from } t \textit{ to } t{+}1.$$

$\eta_t^j \equiv$ number of trips to the bank to withdraw money.

$\gamma_t \equiv$ real transactions cost for each withdrawal of money.

$M_t^s \equiv$ nominal aggregate money supply (will we use M1 = currency + checkable deposits).

$M_t^d \equiv$ nominal aggregate money demand, which is just $\sum_{j=1}^{J} \bar{m}_t^j$.

$\pi_t \equiv$ inflation rate, the relative price of future money (or dollars) in terms of current money. $1+\pi_t = P_{t+1}/P_t$.

$\pi_t^e \equiv$ expected inflation rate. $1+\pi_t^e = P_{t+1}^e/P_t$.

$R_t \equiv$ nominal interest rate, the future dollars received (or paid) by buying (or selling) nominal bonds in period t. $(1+R_t)=(1+r_t)(1+\pi_t)$. We can also use this relation to define expected real interest rates by $(1+R_t)=(1+r_t^e)(1+\pi_t^e)$.

$DC_F \equiv$ Government securities held by the Fed (at time t).

$X \equiv$ Foreign exchange held as reserves by the Fed (at time t).

$Cu \equiv$ Currency (at time t).

$CBR \equiv$ Commercial Bank reserves (at time t).

$MB_t \equiv$ Monetary Base = Cu + CBR.

$DC_{CB} \equiv$ Loans and Government Securities held by Commercial Banks (at time t).

$D \equiv$ Checkable deposits (at time t).

$re \equiv CBR/D$, where CBR are both required and excess reserves.

$cu \equiv Cu/D$.

$R^{FF} \equiv$ Fed Funds interest rate.

$R^{D} \equiv$ Federal Reserve discount rate.

$\mu_t \equiv$ money supply growth rate. $(1+\mu_t) = M^s_{t+1}/M^s_t$.

$V_t \equiv$ (income) velocity of money.

$Q^b_t \equiv$ the nominal price of bonds, which can be derived from setting the marginal utility cost of buying the bond to the marginal utility benefit of buying the bond

$$Q_t^b = \frac{1}{1+\rho} E\left[\frac{\Delta U(c_{t+1})P_t}{\Delta U(c_t)P_{t+1}} \mid \Im_t\right]$$

where $\rho \equiv$ individuals' rate of impatience, so that $1/(1+\rho)$ is the individual's discount factor on future utility, where $\Delta U(c_t) \equiv$ additions to utility, and where

$$E[Z \mid \Im_t]$$

denotes the forecast or expectation of Z conditional on information available at time t.

$Q^s_t \equiv$ the nominal price of stocks, which can be derived from setting the marginal utility cost of buying the stock to the marginal utility benefit of buying the stock

$$\frac{Q_t^s}{P_t} = \frac{1}{1+\rho} E\left[\frac{\Delta U(c_{t+1})\left(Q^s_{t+1} + d_{t+1}\right)}{\Delta U(c_t)P_{t+1}} \mid \Im_t\right]$$

where $d_t \equiv$ nominal dividends at time t.

Math Fact 1: $E[X_t \cdot Z_t \mid I_t] = E[X_t \mid I_t] \cdot E[Z_t \mid I_t] + Cov(X_t, Z_t \mid I_t)$

$B^g_t \equiv$ government supply of nominal bonds.

$B^f_t \equiv$ net holdings of foreign nominal bonds. That is, foreign bonds held by U.S. citizens minus U.S. bonds held by foreiners.

$Ex_t \equiv$ real exports.

$Im_t \equiv$ real imports.

current account $= P_t Ex_t - P^f_t Im_t / e_t + R_{t-1} B^f_{t-1} / e_t$.

capital account $= B^f_t - B^f_{t-1}$.

$e_t \equiv$ exchange rate, foreign currency units per dollar.

$f^1_t \equiv$ forward exchange rate, foreign currency units per dollar traded at time t+1 contracted at time t.

$r^w_t \equiv$ world real interest rate.

3.

WHARTON REPROGRAPHICS

3) PRACTICE EXAMS

Course 6N:228 Dean Corbae
Spring 1995

Exam #1

For over a year, the Fed Chairman Alan Greenspan has been very worried about the economy "overheating" leading to inflation and ultimately higher nominal interest rates. One argument for his claim is that consumers were impatient and raised their desired consumption. I want you to use the analysis in class to evaluate the effects on real interest rates, real output, and consumer prices of a switch in agents' preferences such that individuals become more impatient for current consumption and leisure.

I would suggest that you proceed in the following steps. Analyze the effect of a change in preferences of a representative individual. You might want to start with an individual who consumes his endowment.

First, show how the marginal tax increase from say $\tau = 0$ to $\tau > 0$ affects a productive agent's labor supply decision in period t+1. The tax affects productive opportunities so that $y_{t+1} = (1-\tau)\theta_{t+1}f(n_{t+1})$. Assume that substitution effects outweigh income effects. At the same time, you should explain what will happen to future consumption demand. Note that the *intra*temporal decision of how much to work and consume in any given period (including t+1) can be formalized using the labor/leisure choice diagram.

Second, if the agent is able to borrow or lend, how might the future tax affect her current labor supply? That is, how would she substitute between current and future leisure? How does this affect the present discounted value of the agent's after-tax income? How does it affect current consumption and savings or borrowing? Note that the *inter*temporal decision of how much to consume of goods or leisure today versus the future can be formalized using the Fisher diagram.

Third, use your predictions about individuals' consumption and labor supply decisions to make predictions about goods, bond, and money market prices and quantities. In particular, what happens to *current* real interest rates, real output, and prices in reaction to the announcement of the *future* tax increase?

If you have time, you might want to discuss the effects of the tax on *future* real interest rates, real output, and prices as well as addressing how your answers would be different if it was a permanent tax rise versus a temporary one.

A perfect answer is one that provides both an intuitive explanation to the above questions, as well as diagrammatic support via the model we've studied in class.

Course 6N:228 Dean Corbae
Spring 1995

Exam #2

On May 1, the Wall Street Journal reported that the economy expanded at the slowest rate since the summer of 1993. The WSJ (p. A2) called it a "widely anticipated slowdown" and reported that "Most economists said they expect growth to continue this year at (the same low rate)". On May 4, the WSJ (p. A2) reported that the bond market rallied as investors were cheered by new signs of a slowing economy (the sign being the third straight drop in the index of leading indicators). On May 8, the WSJ reported (p. A2) that "consumers are keeping a tighter grip on their wallets (i.e. a slowdown in the rate of consumer spending)" and that civilian employment was down and wages were flat. Finally, with respect to the recent woes of the U.S. dollar against the yen (i.e. its nearly 20% drop from the beginning of the year to the end of April), the WSJ wrote on May 8 (p. C17) "Last week's bond market rally isn't likely to attract the foreign capital (or asset flows) the U.S. needs to help boost the dollar". The WSJ went on to say "a slower growth pace could decrease import demand, and in turn improve the U.S. trade deficit".

In summary, the recent reports in the WSJ of a *current and expected future slowdown* were accompanied by: declines in interest rates, output, and employment, lower consumer price inflation, a depreciation of the dollar, and some improvement in the trade balance.

You are to analyze these facts using the model presented in class. In particular, you are to trace the effects of a **decrease in current θ_t and expected future productivity θ_{t+1}** on current real interest rates, real output, the composition of private spending (consumption and investment), consumer prices, employment and real wages in a closed economy. Then you are to consider the effects in an open economy where funds flow to where real returns are highest.

In the closed economy write-up, you should first briefly explain how a decline in current and anticipated future productivity affects consumption and labor supply behavior of households (10 points) as well as firms hiring and investment demands (10 points). To save time, I do not expect you to provide labor/leisure or Fisher diagrams to explain the individual household or firm decisions. Simply provide an argument like "If households expect a decrease in current and future productivity, they would substitute out of ...." or "If firms expect a decrease in current and future productivity, this would decrease the marginal benefit of ...." Given your explanation of individual behavior, use goods (10 points), bond (10 points), money (10 points), and labor (10 points) market diagrams to explore what happens to real interest rates, real output, consumer prices, employment, real wages, and the composition of private spending. You should assume that the effects on aggregate supply from the decline in θ_t and θ_{t+1} is less than the response of aggregate demand to such shocks (in particular, investment) in the goods market.

Now consider an open economy. What are the consequences of interest rate changes from the first part of your answer on exchange rates and the trade balance (10 points)? You should show this by modifying the goods (10 points) and bond (10 points) market diagrams, as well as including the foreign exchange (10 points) market diagram.

Does the theory predict what was in the WSJ?

Course 6N:228
Fall 1995

Dean Corbae

Exam #2

Directions: At the top of each page you turn in, write only your student number (which is often your Social Security Number) as identification. You have 2 hours to complete the exam. The number of points associated with each portion of the exam is provided after that question.

The 1985 Balanced Budget and Emergency Deficit Control Act (better known as the Gramm-Rudman-Hollings bill) set legal limits on the Federal budget deficit beginning with a limit of $172 billion in fiscal year 1986 and ending with a requirement of budget balance (i.e. zero deficit) in 1991. Obviously, the 1991 requirement was never actually enacted. Why? One argument against the balanced budget requirement is that it *amplifies* the business cycle. That is, if the economy experiences a temporary productivity upturn or downturn, the government may have to change tax rates or expenditure temporarily in order to keep the budget balanced when faced with a varying tax base (household and corporate income levels).

Using the framework we've developed in class, analyze the effect of a *temporary* decrease in current productivity (i.e. a temporary fall in θ_t) in the presence of a balanced budget requirement which states that in response to a fall in national income (and hence tax revenues) the government must decrease its expenditure (i.e. it must decrease G_t temporarily). What can we expect to happen to output (both its level and the composition of expenditure on consumption, investment, government expenditure, and the current account), employment, real wages, real interest rates, aggregate prices, and nominal exchange rates with a balanced budget rule in place?

Part (a) Begin by examining what happens in the labor market when productivity falls. In particular, if firms own the technology, how will they react to a temporary decrease in θ_t? Explain. (10 points)

Part (b) How does this translate into the household's consumption and savings decisions? In particular, what do the results in part (a) for the real wage imply for current consumption and savings? You need **not** show your results graphically in the Fisher diagram, simply explain why households act the way they do. (5 points)

Part (c) Explain and show what the results of parts (a) and (b) imply about aggregate demand and supply in the goods market in a closed economy. (10 points)

Part (d) Given your prediction about Y_t in part (c), what happens to tax revenues (since tax revenues are simply the tax rate times real income $T_t = \tau_t Y_t$)? (5 points) What must the government do to its expenditure (G_t) temporarily to balance the government budget? (5 points) Show how this additional effect alters the goods market relative to part (c). Has it amplified the change in output? (5 points) In the closed economy, what happens

to the composition of expenditure (C_t, I_t, and G_t) in response to the productivity shock and the balanced budget rule? (5 points)

Part (e) How does the end result in the goods market in part (d) translate into the bond market and money market in a closed economy? What happens to P_t? (15 points)

Part (f) If savings can flow internationally to the highest yield, where will domestic and foreign residents move their funds? Show how the bond market diagram in part (e) changes. (5 points) How do nominal exchange rates respond to these savings flows? Show your result in the foreign exchange market diagram. (10 points)

Part (g) What is the relationship between international flows of savings and flows of goods? In particular, what happens to the U.S. trade balance? Explain and show your results graphically in the goods market diagram. (20 points)

Summarize the open economy effects on Y_t, C_t, I_t, the trade balance (exports-imports), r_t, N_t, w_t, P_t, e_t. (5 points)